
Final Report Phase I RCRA Facility Investigation for Appendix I Sites

VOLUME III-A

SWMU-24/32, Industrial Wastewater Treatment Plant/
Sanitary Wastewater Treatment Plant



Department of the Air Force
Oklahoma City Air Logistics Center
Tinker Air Force Base, Oklahoma

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFLC	Air Force Logistics Command
AFMC	Air Force Materiel Command
AFSC	Air Force Systems Command
AMC	Air Materiel Command
AOC	Area of concern
API	American Petroleum Institute
AQUIS	Air Quality Utility Information System
ASTM	American Society for Testing and Materials
AWAC	Airborne Warning and Control
BF	Bioconcentration factor
bgs	Below ground surface
BNA	Base/neutral/acid - extractable
BTEX	Benzene, toluene, ethylbenzene, xylenes
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
cm/sec	Centimeters per second
CME	Central Mine Equipment Company
CMS	Corrective measures study
COD	Chemical oxygen demand
COE	US Army Corps of Engineers or USACE
CWA	Clean Water Act
DCA	Dichloroethane
DCE	Dichloroethene

DCQAP	Data Collection Quality Assurance Plan
DNPH	Dinitrophenylhydrazine
DOD	US Department of Defense
DQO	Data quality objective
EM	Environmental Management
EPA	Environmental Protection Agency
ES	Engineering-Science, Inc.
ESC	East Soldier Creek
FAA	Federal Aviation Administration
FID	Flame ionization detector
GC	Gas chromatograph
gpd	Gallons per day
gpm	Gallons per minute
H ₂ S	Hydrogen sulfide
ICP	Inductively coupled plasma atomic emission spectroscopy
ID	Identification
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program information management systems
IWTP	Industrial wastewater treatment plant
K _H	Henry's Law constant
K _{oc}	Organic carbon partition coefficient
L/min	Liters per minute
LDR	Land disposal restrictions
LEL	Lower explosive limit
m ³	Cubic meter
MDL	Method detection limit
MEK	2-Butanone (methyl ethyl ketone)
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mgd	Million gallons per day
min	Minute
mL	Milliliter

mL/min	Milliliters per minute
mph	Miles per hour
MQA	Method quantitation limit
MS/MSD	Matrix spike/matrix spike duplicate
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
ng/m ³	Nanograms per cubic meter
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OC-ALC	Oklahoma City Air Logistics Center
OCAMA	Oklahoma City Air Materiel Area
OSDH	Oklahoma State Department of Health
OSPC	Oklahoma State Planar Coordinates
OVA	Organic vapor analyzer
PAH	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PID	Photoionization detector
POTW	Publicly owned treatment works
ppb	Parts per billion
ppm	Parts per million
ppmv	Parts per million, volume per volume
PQL	Practical quantitation limit
PSI	Professional Service Industries, Inc.
PUF	Polyurethane foam filter
PVC	Polyvinyl chloride
QA	Quality assurance
QA/QC	Quality assurance/quality control
RAS	Return activated sludge
RCP	Recirculation pit
RCRA	Resource Conservation and Recovery Act

RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial investigation
RI/FS	Remedial investigation/feasibility study
SCC	Solids contact clarifier
SCFH	Standard cubic feet per hour
SGB	Bioenvironmental Engineering Office
SVOC	Semivolatile organic compound
SWD	Sidewall depth
SWMU	Solid waste management unit
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SWMU 32.8	Drying Beds
SWTP	Sanitary wastewater treatment plant
TAC	Tactical Air Command

TCA	Trichloroethane
TCE	Trichloroethene
TCLP	Toxicity characterization leaching procedure
TPH	Total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSP	Total suspended particles
USAF	United States Air Force
USGS	United States Geological Survey
VLF	Very low frequency
VOA	Volatile organic analysis
VOC	Volatile organic compound
WWTF	Wastewater treatment facility
$\mu\text{g}/\text{kg}$	Micrograms per kilogram
$\mu\text{g}/\text{L}$	Micrograms per liter
$^{\circ}\text{C}$	Degrees Celsius
$^{\circ}\text{F}$	Degrees Fahrenheit
(')	Feet below ground surface

EXECUTIVE SUMMARY

This report presents the field methods, results, conclusions and recommendations of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) of twenty solid waste management units (SWMUs) at the wastewater treatment facility (WWTF) at Tinker Air Force Base, Oklahoma. This work was performed by Engineering-Science, Inc. under contract to the Oklahoma City Air Logistics Center (OC-ALC), under contract number F34650-93-D-0106, delivery order 5000.

GOALS AND SCOPE

This investigation was planned and executed to meet the requirements of the U.S. Air Force Installation Restoration Program (IRP), the RCRA permit issued to Tinker AFB by the U.S. Environmental Protection Agency (EPA), associated technical guidance for RFI projects, and the basewide RFI workplan.

The goals of the RFI were to determine if contaminant releases have occurred from twenty SWMUs and one non-SWMU unit at the WWTF and to determine if further action should be taken. The investigation focused on releases to soils and air. Releases to the groundwater from this area are being investigated in a separate study. Groundwater under the WWTF is known to be contaminated and has been designated an operable unit of the Tinker AFB Building 3001 National Priorities List (NPL) site.

The twenty SWMUs consist of thirteen units from the industrial wastewater treatment plant (IWTP) and seven units in the sanitary wastewater treatment plant (SWTP) portions of the WWTF. The additional unit investigated was the recirculation pit (RCP) part of the IWTP.

ENVIRONMENTAL SETTING

Tinker AFB is a U.S. Air Force installation located in Oklahoma County in central Oklahoma, approximately 8 miles southeast of downtown Oklahoma City. The base houses the Air Logistics Center, two Air Combat Command (ACC) units, and is the main operating base for Airborne Warning and Control (AWAC) aircraft. The base is surrounded by three municipalities: Del City on the northwest, Midwest City on the north, and Oklahoma City on the east, south, and southwest. Del City and Midwest City are heavily populated commercial and residential districts.

Tinker AFB is located on the Great Plains where the climate is temperate and precipitation averages 33 inches per year. Winds in the Oklahoma City area are

variable, prevailing from the south. The average wind speed is 14 miles per hour (mph), and the annual percent of calm winds is 2.05.

The WWTF is located on 4 acres at the northeast corner of Tinker AFB and consists of two separate treatment plants. The SWTP was originally constructed in 1943. It is currently used to treat approximately 465,000 gallons per day (gpd) of domestic wastewater.

The IWTP was constructed in 1963 for treatment of painting and stripping wastestreams. Industrial wastewater is collected in a segregated process sewer system that conveys the water to the IWTP. IWTP influent flow varies from 0.2 MGD to 1.4 MGD. Base operations generate wastewater contaminated with oil and grease, heavy metals, and organics (e.g., methylene chloride and phenols).

Both the IWTP and the SWTP operate under a NPDES permit, and discharge, along with storm water runoff, via ten outfalls into a tributary of East Soldier Creek. Domestic waste from the west side of Tinker AFB is discharged via a separate collection system into the Oklahoma City publicly owned treatment works (POTW).

The topography of the WWTF is gently sloping with locally steep features in the vicinity of the SWTP. The elevation of the study area ranges from approximately 1,265 feet at the northwest corner of the site to 1,230 feet along East Soldier Creek. Surface water drains principally from west to east towards East Soldier Creek.

The two primary rock units that outcrop at Tinker AFB are the Permian-age Garber-Wellington Formation and the Hennessey Group. The Garber-Wellington Formation, estimated to be approximately 900 feet thick in the Tinker AFB area, consists of lenticular and interbedded sandstone, shale, and siltstone. The stratigraphy beneath the site is characterized by interbedded, discontinuous units of sandstone, siltstone, and shale varying in thickness from 1 to 30 feet. The depth to rock ranges from 5.5 feet to 15 feet across the site with no apparent trend. The Hennessey shale is absent at the WWTF.

Tinker AFB lies within the limits of the Garber-Wellington Groundwater Basin. The Garber Sandstone and the Wellington Formation are considered to be a single aquifer and provide the most significant source of potable groundwater supplies in the Oklahoma City area. The average depth to water in the producing zone (deeper sandstone strata) of this aquifer is approximately 250 feet.

Water in the Garber-Wellington is normally encountered at a depth of 60 to 80 feet at Tinker AFB. Groundwater occurs above the producing zone in what is known as the Regional Aquifer Zone. The average depth to water in the Regional Aquifer Zone is approximately 50 feet.

Recharge of the Garber-Wellington Aquifer is accomplished principally by rainfall infiltration and by percolation of surface waters crossing the area of outcrop. Most of Tinker AFB is located in an aquifer outcrop area, and as such is situated in a recharge zone. The aquifer, therefore, is susceptible to contamination in the study area.

The quality of groundwater derived from the Garber-Wellington Aquifer is generally good, although wide variations in the concentrations of some constituents are known to occur. Wells drilled to depths greater than 900 feet may encounter a saline zone.

Drainage from Tinker AFB is generally north to the North Canadian River via three primary watersheds: Crutch Creek, Kuhlman Creek, and Soldier Creek. The northeast portion of the base is drained primarily by tributaries of Soldier Creek, which is a tributary of Crutch Creek. A tributary of East Soldier Creek runs northeast through the WWTF and receives permitted discharges from the IWTP, SWTP, and stormwater runoff outfalls.

FIELD INVESTIGATION

Field work was conducted from September 1993 through November 1993. The field team collected influent wastewater samples, 195 soil gas samples, 20 surface soil samples, 14 sediment samples from East Soldier Creek, and drilled and sampled 87 soil borings. The field teams also collected more than 600 air samples to characterize source emissions, process area emissions, and fence line ambient air conditions. Two meteorological stations were established to collect weather data.

RESULTS AND RECOMMENDATIONS

Samples collected from each SWMU showed some degree of releases from the units. The actual levels of some contaminants in samples may be artificially high because several constituents of the industrial wastewater treated at the facility are also common laboratory contaminants, including acetone, methylene chloride, and bis(2-ethylhexyl)phthalate.

The recommendations presented here are based on an overall evaluation of the evidence of releases from each SWMU and the magnitude of releases, rather than a specific action level. No specific action levels have been established for remediation of subsurface soils at this site. General comparison criteria were consulted in the evaluation, including background concentration ranges for metals derived from a 1991 USGS report. Other comparison criteria are found in the proposed action levels listed in "Corrective Action for Solid Waste Units at Hazardous Waste Management Facilities, Proposed Rule" (EPA 1990).

The SWMUs recommended for a corrective measures study (CMS) are those with clear evidence of significant releases to the environment. If the use of the site changes in the future, the sites for which no further action has been recommended at this time may need to be reevaluated.

Interim corrective measures to address immediate impacts to human health and the environment are not needed at this time. The results of the investigation did not indicate adverse exposure to hazardous constituents is occurring or imminent.

No Further Action

Given the nature of the contamination and present use of the site, no further action is recommended for the following SWMUs at this time. However, a CMS at the SWMUs may be considered in the future if site use changes.

SWMU 24.1 (Lift Station) Low levels of chlorinated solvents and BTEX compounds were detected in the soil gas. Soil samples contained low concentrations of methylene chloride. One sample contained a high concentration of barium at 16 ft BGS. The concentrations of constituents in the samples are not consistent with a significant release from this unit.

SWMU 24.4 (Valve Vault) Soil gas samples were not collected at this SWMU. Nearby soil gas samples contained trace concentrations of DCE. One soil boring was drilled at this SWMU. Low concentrations of acetone were present throughout the soil boring. Metal concentrations were below or within background concentration ranges.

SWMU 24.5 (Equalization Basin) Low levels of chlorinated solvents were found in the soil gas samples. PCE was detected at low levels. Barium, chromium, and cadmium concentrations were above background ranges in at least one sample each. Trace to low concentrations of toluene were measured in the subsurface soil samples. While some evidence of a release is present, the concentrations do not appear to warrant a CMS at this time.

SWMU 24.6 (Main Flow Valve) Soil gas samples contained trace levels of DCA. Low concentrations of acetone and toluene were detected in soil samples.

SWMU 24.7 (Mixing Basins 1, 2, 3) Trace levels of DCE were detected in the soil gas, and low concentrations of acetone were detected in soil samples.

SWMU 24.8 (Solids Clarifier) Trace concentrations of PCE and DCE were found in the soil gas. Low levels of acetone and methylene chloride were detected in soil samples. Metal concentrations were within background ranges.

SWMU 24.9 (Wet Well Lift Station) Trace levels of PCE and toluene and low levels of DCE were found in the soil gas. PCE was detected in one shallow soil sample. Metal concentrations were within background ranges.

SWMU 32.1 (Parshall Flume) Soil gas samples contained trace concentrations of DCE. Soil samples contained low levels of acetone. PCE, toluene, and chloroform were detected in one sample. The surface soil samples contained trace levels of PAHs.

SWMU 32.2 (Flocculation Chambers) Low levels of DCE and vinyl chloride were found in the soil gas. Low levels of acetone, methylene chloride, and phthalates were detected in soil samples and laboratory blanks. Arsenic and zinc concentrations in two soil samples each were above background concentration ranges.

SWMU 32.3 (Primary Clarifiers) One soil gas sample contained low levels of DCE and DCA. Soil samples contained low levels of acetone and methylene

chloride. One soil sample also contained several PAHs at low concentrations. Selenium concentrations were above average background concentrations.

SWMU 32.4 (Trickling Filters) All of the soil gas samples contained trace levels of DCE, and most contained PCE and DCA. Toluene was detected at low levels in three soil gas samples. Low levels of toluene and PCE were also found in the soil samples. Arsenic concentration was above the background range in one soil sample. Although there is evidence of a release, the concentrations of contaminants do not appear to warrant a CMS at this time.

SWMU 32.5 (Final Clarifiers) Acetone, methylene chloride, PCE, and toluene were detected in soil samples. Several soil samples contained phenol compounds which were a result of laboratory contamination.

SWMU 32.6 (Former Chlorine Contact Chamber) Soil gas samples collected at this site did not contain any target compounds. Chromium concentration was above the background range.

Corrective Measures Study

Results from this investigation indicate that several SWMUs have had significant releases to the environment. A corrective measures study is necessary to identify and develop corrective measure alternatives for sites which may pose a threat to human health or the environment. A CMS is recommended for the following SWMUs:

SWMU 24.2 (D-1 and D-2 Tanks) Soil gas samples contained moderate to high concentrations of vinyl chloride. Subsurface soils had moderate concentrations of acetone, MEK, and toluene. Surface soils were contaminated with PAHs and several other compounds. Surface soils also showed visible evidence of releases, including stains and stressed vegetation.

SWMU 24.3 (Oil Separator) Soil gas samples indicated contamination by chlorinated solvents, especially vinyl chloride. Subsurface soils did not have high concentrations of contaminants. Low concentrations of benzoic acid and phthalates were detected in several subsurface soil samples. Metals concentrations were within background concentration ranges. Surface soils were contaminated with low to moderate concentrations of hexanone, toluene, xylene, and phthalates, and low concentrations of Aroclor 1254. Cadmium, chromium, lead, and zinc were also detected in surface soils above background concentration ranges.

SWMU 24.10 (Softener Basins) Soil gas samples contained trace levels of chlorinated solvents. PCE, acetone, methylene chloride, and toluene were found in soil samples. Several PAHs were found in one soil boring at 6-7 feet bgs.

SWMU 24.11 (Activated Sludge Unit) Soil gas samples contained trace concentrations of DCE and DCA. PCE was detected in one subsurface sample. The apparent phenol contamination in several soil samples was the result of laboratory contamination. Elevated arsenic concentration was found in one soil sample.

SWMU 24.12 (Secondary Clarifier) Low concentrations of DCE and trace amounts of DCA and PCE were detected in all soil gas samples. PCE was detected in two soil samples. Barium was detected in subsurface soil samples above the background concentration range.

SWMU 24.19 (Industrial Sludge Drying Beds) Very high concentrations of chlorinated solvents were detected in the soil gas samples. PCE and DCE were detected in most soil samples. Cyanide, PCBs, and high concentrations of cadmium, chromium, lead, and nickel were detected in surface soils.

SWMU 32.8 (Drying Beds) High levels of TCE, TCA, DCA, and PCE were detected in the soil gas. Acetone, PCE, and toluene were detected in most of the soil samples. Surface soil samples contained low concentrations of mercury.

Recirculation Pit Soil gas samples contained both DCE and DCA. High concentrations of gasoline components, including ethylbenzene, toluene, and xylene, were found in the soil samples. The soil samples also contained elevated levels of barium and chromium.

Air Quality Considerations

Results of the analysis of the air samples indicate that some organic constituents are being released from the various open-top process units. As expected, the constituents found in the source emission samples correspond to those found in the wastewater. Many of the same constituents found in the source emissions were also detected in the process area and ambient air samples at much lower concentrations.

The results of air emission sampling should be evaluated as part of the CMS, or as a second phase of the RFI. This evaluation should consider constituent dispersion and potential off-site impacts. If a potential for adverse health or environmental impact is indicated, consideration of control measures can be incorporated into the CMS for SWMUs which may be a significant source of release.

SECTION 1

INTRODUCTION

1.1 PURPOSE

This report describes the field methods, results, conclusions, and recommendations of a RCRA Facility Investigation (RFI) conducted at the wastewater treatment facility (WWTF) at Tinker Air Force Base (AFB) in 1993. This work is performed by Engineering-Science (ES) under contract to Oklahoma City Air Logistics Center.

1.2 REGULATORY BASIS

In 1981, the US Air Force Installation Restoration Program (IRP) was established at Tinker AFB. The IRP is a comprehensive program funded and managed by the Department of Defense (DOD). The purpose of the IRP is to identify, investigate, and clean up contamination from releases of hazardous substances, pollutants, and contaminants. The IRP also addresses other environmental damage such as unexploded ordnance. IRP sites may or may not be listed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL). NPL sites at Tinker AFB include Building 3001 and Soldier Creek.

The Tinker AFB RCRA Part B permit was approved by the US Environmental Protection Agency (EPA) on July 1, 1991. As part of the permitting process, a RCRA Facility Assessment (RFA) was conducted identifying forty-three solid waste management units (SWMUs) and two areas of concern (AOCs). The permit specifies that RFIs be conducted for the SWMUs and AOCs at Tinker AFB. Twenty of the forty-three SWMUs are located at the WWTF. This report presents the results of the RFI of the SWMUs at the WWTF at Tinker AFB.

1.3 INVESTIGATION OBJECTIVES AND SCOPE

The objectives of the RFI were to determine if contaminant releases to the environment have occurred at each SWMU and to determine the nature and extent of the contaminant releases. Information was gathered during the RFI to support a Corrective Measures Study or interim measures, if deemed necessary. The scope of the RFI was limited to investigation of air, soil, and surface water pathways. Groundwater investigations will be conducted in a separate study. Specific RFI tasks included:

- Investigation of all listed SWMUs at the WWTF to include ambient air and process systems vaporization monitoring, soil gas analyses, and soil analyses.
- Ambient air monitoring and sampling at thirteen stations. Atmospheric and climatological data, including wind speed and direction, humidity, ambient temperature, and atmospheric pressure, were collected during the monitoring period. Air samples were analyzed for total volatile and semivolatile organic compounds.
- Vapor emissions monitoring and sampling from open-top storage tanks, valve pits, the recirculation pit, and other open processing systems at twenty-five sampling stations. Real-time sampling and analyses were accomplished by use of an onsite gas chromatograph (GC). Climatological conditions were monitored at the vapor emission monitoring stations, as described for the ambient air monitoring above.
- Stream sediment sampling at East Soldier Creek. Sediment samples were collected at six stations during two sampling events 30 days apart. These samples were analyzed for RCRA metals, total cyanides, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs), including polychlorinated biphenyls (PCBs), phenol, and cresols.
- A soil gas survey of the entire site. Emphasis was on areas adjacent to tanks D-1 and D-2, the oil separator, the recirculation pit, the active sludge drying beds, and the abandoned sludge drying beds. A field GC was used to detect VOCs in the soil gas.
- Surface soils sampling at twenty locations. The soil samples were analyzed for the same constituents described above for the stream sediment sampling.
- Sampling of subsurface soils at eighty-nine locations to a maximum depth of 18 feet. Samples were collected from twelve SWMUs for analyses for geotechnical parameters. Two or three samples from each boring were analyzed for RCRA metals, total cyanides, VOCs, and SVOCs, including phenol and cresols. All soil borings were logged using a natural gamma-ray geophysical instrument.

1.4 REPORT ORGANIZATION

This report is organized into seven sections, including this introduction. The second section presents a description of the environmental setting at Tinker AFB and a description of each SWMU. The third section contains the data collection methodology. The fourth section describes the results of the investigation for each SWMU. The fifth and sixth sections present a discussion of the area-wide results and fate and transport mechanisms, respectively. The seventh section presents a summary and recommendations for future actions for each SWMU.

SECTION 2

BACKGROUND

2.1 INSTALLATION DESCRIPTION AND HISTORY

2.1.1 Installation Description

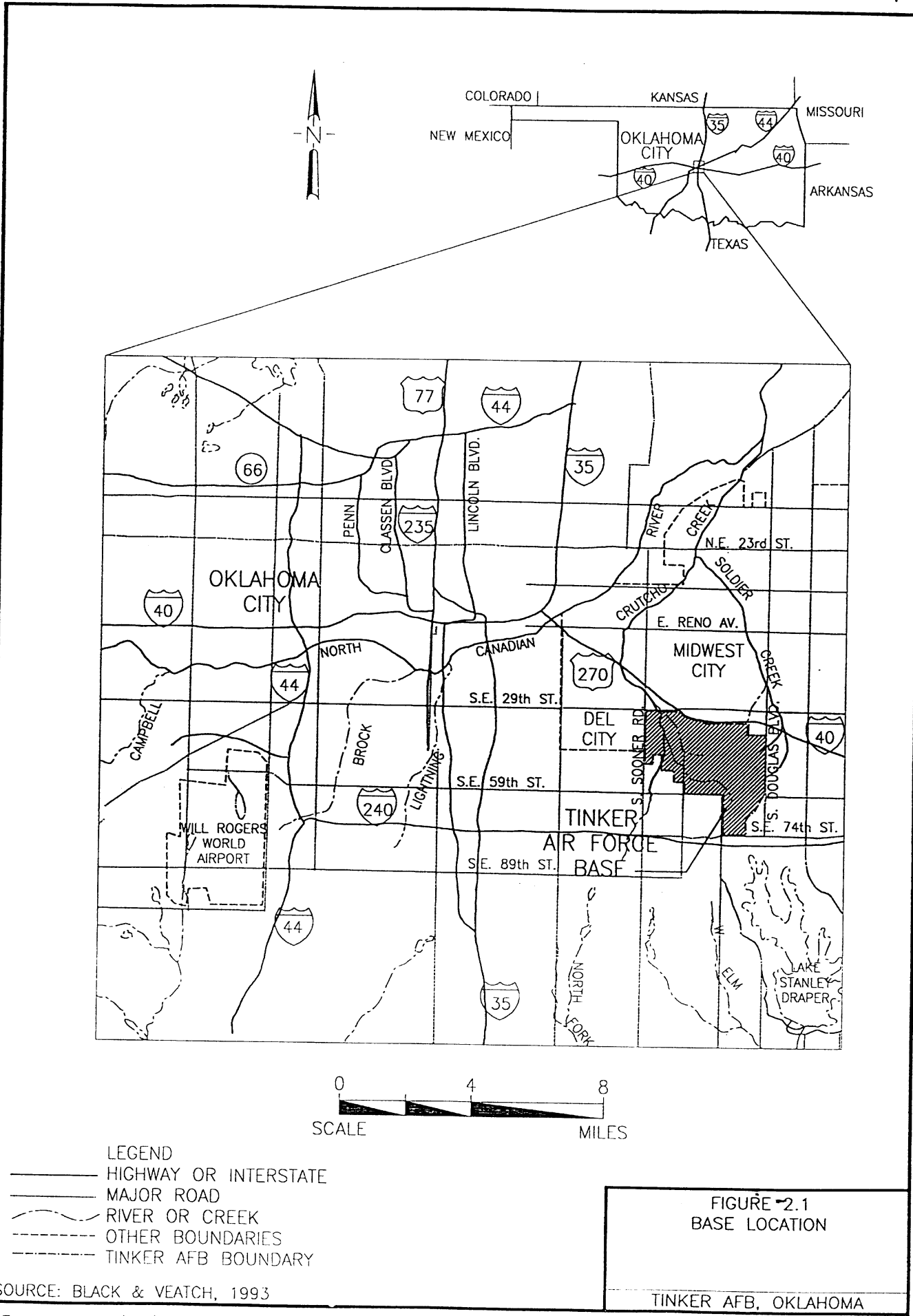
Tinker AFB is a US Air Force installation located in Oklahoma County in central Oklahoma, approximately 8 miles southeast of downtown Oklahoma City, as shown on Figure 2.1. The base encompasses 4,541 acres and contains approximately 500 buildings. Figure 2.2 shows the areal extent of the base and major landmarks. Tinker AFB, as a worldwide repair depot, manages and maintains the B-1B, B-2, B-52, E-3, and multipurpose 135 series aircraft. Also managed at the base are the SRAM, SRAMII, ALCM, and GLCM missile systems, as well as the USAF Harpoon Missile. The base houses the Air Logistics Center and two Air Combat Command (ACC) units, and is the main operating base for Airborne Warning and Control (AWAC) aircraft. Approximately 22,750 people are currently employed at Tinker AFB (Chamber of Commerce, 1992).

The focus of the RFI is on the WWTF located within a 4-acre area in the northeast corner of Tinker AFB. This facility consists of a sanitary wastewater treatment plant (SWTP) and an industrial wastewater treatment plant (IWTP). Figure 2.3 shows the general layout of the WWTF. The SWTP was constructed in 1943 for the treatment of sanitary wastewaters from the east side of Tinker AFB and the Douglas Aircraft Plant. The IWTP was constructed in 1963 for the batch process treatment of painting and stripping solutions. Several upgrades have been performed at the IWTP since that time, and the plant now processes an average of approximately 1.2 million gallons of wastewater per day (mgd). Both facilities operate under a National Pollutant Discharge Elimination System (NPDES) permit to discharge into East Soldier Creek, as shown on Figure 2.2.

2.1.2 Previous Investigations

Previous investigations have confirmed soil, surface water, and groundwater contamination at the site. A groundwater plume beneath the site and the discharge stream (East Soldier Creek) has been designated an operable unit of the building 3001 NPL site. Contamination at the site includes heavy metals, cyanides, VOCs, phenols, and various other SVOCs. A historical review of the site included review of the following documents:

- Draft Final IWTP Remedial Investigation Report,



SOURCE: BLACK & VEATCH, 1993

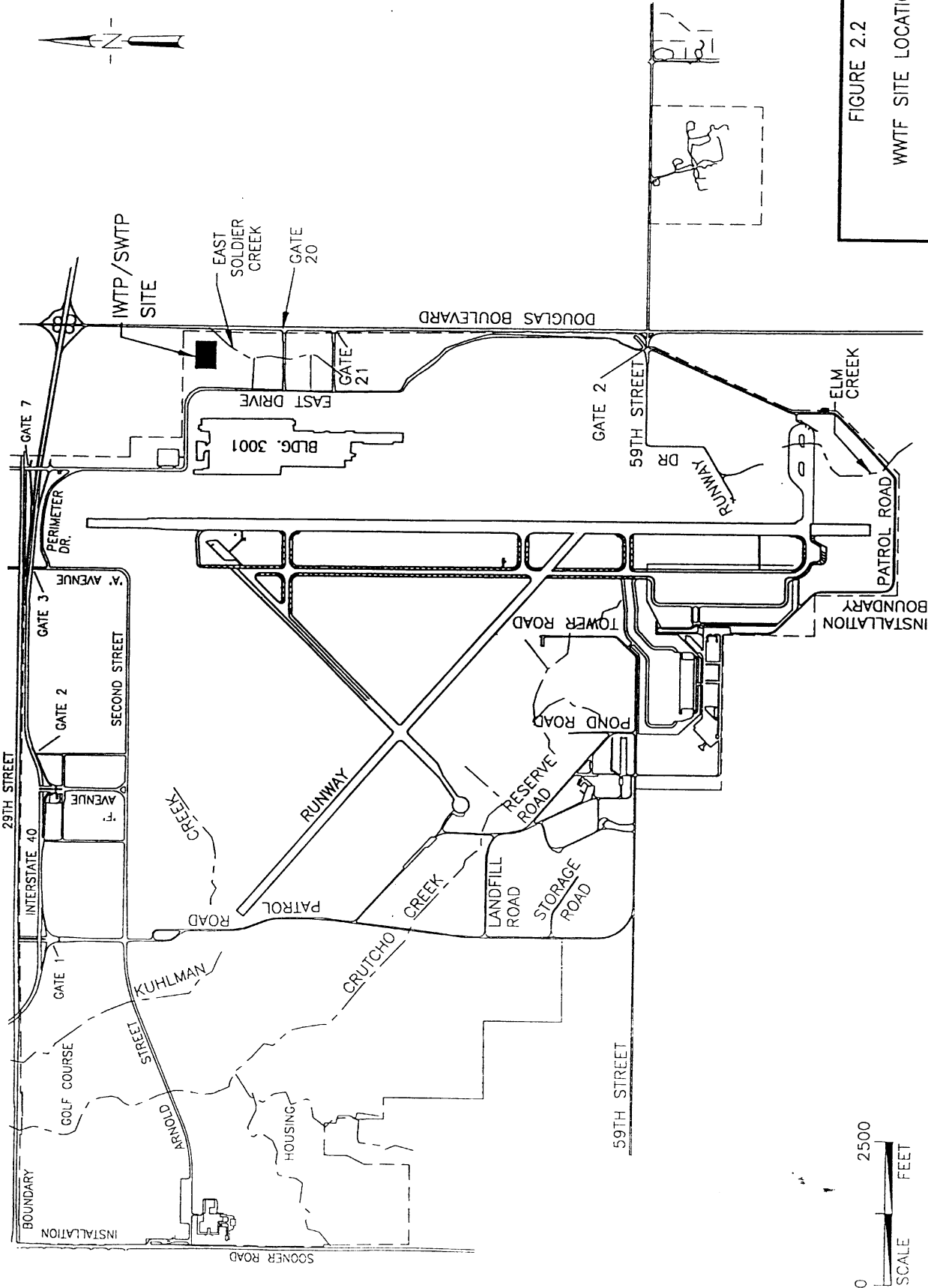
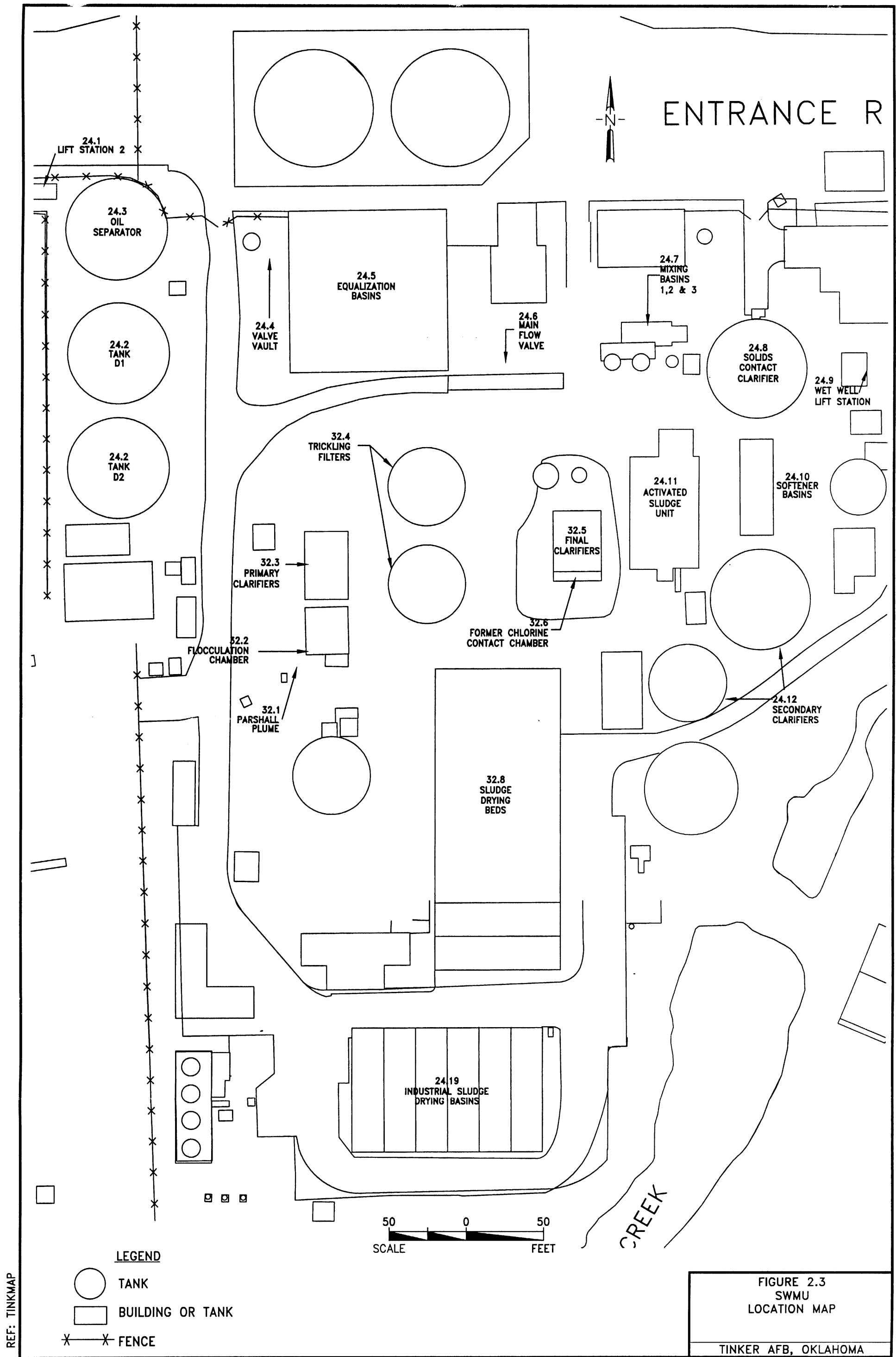


FIGURE 2.2

WWTF SITE LOCATION

TINKER AFB, OKLAHOMA



REF: TINKMAP

- Off-Base Investigation Report,
- Building 3001 Remedial Investigation Report,
- Final Work Plan for Tank Removal, and
- Industrial Waste Treatment Plant Abandoned Waste Tanks IRP Report.

2.1.3 Installation History

The site for Tinker Air Force Base was selected by the Site Board of the Army Air Force in March 1941. Two months later, approval was granted to build a maintenance and supply depot southeast of Oklahoma City on a 960-acre site donated by Oklahoma City. On May 21, 1941, approximately 7 months before the United States formally entered World War II, the proposed installation was designated the Midwest Air Depot. Groundbreaking ceremonies were conducted on July 30, 1941, with subsequent activation of the installation on March 1, 1942. During this period, Midwest City was formed as a new town to provide housing and community facilities for the air depot. The original land acquisition for Midwest City consisted of 310 acres immediately north of the new air maintenance and supply depot.

During the initial construction of the installation, a nucleus of military and civilian personnel operated from a commercial building in downtown Oklahoma City. The first increment of personnel moved to the installation on July 20, 1942, which, at that time, covered 1,660 acres containing 420 unfinished buildings. As the mission accelerated, so did employment. In October 1943, civilian employment reached a World War II peak of 14,925. During World War II, the Midwest Air Depot was responsible for reconditioning, modifying, and modernizing aircraft, vehicles, and equipment.

The depot was designated "Tinker Field" on October 14, 1942, in honor of Major General Clarence L. Tinker, a native of Oklahoma. The Major General, one-eighth Osage Indian, was killed in action on June 7, 1942, while leading his bomber command on a strike against the Japanese at Wake Island.

The depot was officially dedicated as "Tinker Field" on November 18, 1945. The installation at this time had a value of \$55 million and was among the largest air bases in the United States.

On July 2, 1946, Tinker Field became home to the Oklahoma City Air Materiel Area (OCAMA), following its parent command's redesignation as the Air Materiel Command (AMC). During this time, Tinker became involved in jet engine overhaul and, later, modification of aircraft from storage as part of a massive program to rebuild the nation's airpower. Following the creation of the Department of Defense and the Air Force as a separate military establishment, Tinker Field became "Tinker Air Force Base" on January 13, 1948. Subsequently, the base became the worldwide repair depot for the B-36 aircraft and its first jet aircraft, a B-45, as well as a multitude of other weapons and engines.

The outbreak of the Korean War in 1950 placed new demands on Tinker AFB. Maintenance and repair of aircraft increased 57 percent, largely in support of the Korean action. Further, by August 1952, military and civilian personnel had grown

to an all-time high of almost 29,000. Concurrently, Tinker AFB's air materiel headquarters' responsibilities were enlarged. For example, in January 1954, OCAMA was assigned all logistics functions, from acquisition through operations, for the new B-52 bomber, and also received similar responsibilities for the C/KC-97 and B-47 aircraft. In the late 1950s, management of missiles was added to the logistics mission. Later, during the years from 1961 through 1963, the installation became the specialized repair site for C-135 aircraft and airborne communications equipment, and the single overhaul point for the J-57 engine and related accessories. In 1966, OCAMA was assigned the management of the A-7 attack aircraft.

The United States' involvement in Vietnam had a major impact on OCAMA in the late 1960s. OCAMA managed, bought, repaired, and stored several types of weapons and other items in support of the Vietnam action. During the 1970s, the installation took on new management responsibilities, such as the B-1 bomber, the F-101 engine, and the AGM-86A missile. On April 1, 1974, the name of the command was again changed, from OCAMA to the Oklahoma City Air Logistics Center (OC-ALC), in response to an Air Force reorganization dissolving the Air Materiel Command and creating the Air Force Logistics Command (AFLC). By this time, the real estate value of Tinker AFB had risen to approximately \$166 million.

Two significant mission developments occurred during the 1980s. One was the arrival at Tinker AFB, on April 1, 1985, of the 552nd AWAC Wing, a component of the TAC. The second important development during the 1980s was the increased emphasis on environmental management. In the early 1980s, with a small staff in the Office of the Base Civil Engineer, a separate Directorate of Environmental Management (EM) was formed. The new Directorate grew rapidly as it incorporated functions related to environmental laws such as the Clean Air Act (CAA), Clean Water Act (CWA), RCRA, CERCLA (or Superfund), and Toxic Substances Control Act (TSCA).

As early as 1983, measures to clean up sites at Tinker AFB contaminated by past activities were being undertaken by the Air Force IRP. Two sites, building 3001 and Soldier Creek, have been listed on the CERCLA NPL. Tinker AFB has entered into a Federal Facilities Agreement with EPA and the State of Oklahoma to remediate these sites and to manage its wastewater treatment plant. A RCRA Facility Assessment (RFA) conducted in May 1989 identified eighty SWMUs and nineteen AOCs. The base was issued a RCRA Part B permit on July 1, 1991. The permit specified that an RFI be conducted for forty-three SWMUs. The Directorate of Environmental Management has now grown to approximately 80 personnel, and in 1992 established close working relationships with the Bioenvironmental Office and the Office of Safety.

In 1992, major organizational changes occurred in response to the end of the cold war and the downsizing of the entire military structure. Of most importance to the OC-ALC is the fact that on July 1, 1992, its parent command, the Air Force Logistics Command (AFLC), was merged with the Air Force Systems Command (AFSC) to form a new command entitled the Air Force Materiel Command

(AFMC). This new command comprises 52 percent of the Air Force budget. Eighteen percent of all Air Force personnel and 42 percent of the civilian work force are assigned to the new command. As part of the 1992 reorganization, TAC was merged into the Air Combat Command (ACC).

During 1992, the 50th anniversary year of Tinker AFB, the L-62 Strategic Communications Wing of the US Navy was installed at Tinker AFB, the first installation of a major Navy unit at an Air Force base. The L-62 Strategic Communications Wing is composed of two squadrons of aircraft that maintain Very Low Frequency (VLF) communications with the Navy's ballistic missile-carrying submarines. The E-6A Hermes aircraft, which serve as platforms for the VLF equipment, are similar to the Etches and C-135 aircraft for which Tinker AFB already had primary maintenance and repair responsibility. This fact, plus the mid-continent location from which both Pacific and Atlantic fleets can be serviced, were reasons for choosing Tinker AFB as the main operating base for the Navy's Strategic Communications Wing. Since then, Tinker AFB also has acquired maintenance and repair responsibility for the B-2 stealth bomber and the F-118 stealth fighter.

2.2 ENVIRONMENTAL SETTING

2.2.1 Surface Features

2.2.1.1 Physiography and Regional Topography

Tinker AFB is located in the Osage Plains section of the Central Lowland Physiographic Province. This section lies west of the Ozark Plateau and Ouachita Mountains and east of the High Plains. The landforms of this area are characterized as a belt of gently rolling plains formed on Permian-age shale and sandstone.

The topography of Tinker AFB is characterized by gently rolling hills, broad flat plains, and well-entrenched main streams. Local relief is the result of surface dissection by erosional activity and stream channel development. Surface elevations across the base range from 1,210 feet on the northwest to approximately 1,320 feet at the southeast corner (BVWST, 1993b). The principal surface water drainage ways for Tinker AFB are Crutcho, Kuhlman, and Soldier Creeks. The extreme southern part of the base is drained by Elm Creek, an intermittent stream which flows to the south and discharges into Lake Stanley Draper. Most of the base is drained by Crutcho Creek and its tributary, Kuhlman Creek. Soldier Creek, located mainly to the east of Tinker AFB, flows to the north and discharges into Crutcho Creek. Two tributaries of Soldier Creek, East Soldier Creek and West Soldier Creek, receive surface water drainage from the eastern portion of Tinker AFB. Details of local surface water systems are presented in section 2.2.5.

2.2.1.2 Site Topography and Surface Drainage

The topography of the WWTF is gently sloping with locally steep features in the vicinity of the SWTP. The elevation of the study area ranges from approximately 1,265 feet at the northwest corner of the site to 1,230 feet along East Soldier Creek

in the eastern portion of the site. Surface water drains principally from west to east towards East Soldier Creek. The topography of Tinker AFB and the WWTF are more fully discussed and illustrated in sections 2.2.5 and 2.2.6.

2.2.2 Climatology

Tinker AFB is located in the portion of the United States known as the Great Plains. The climate in the area is characterized by long hot summers with occasional droughts. The average annual temperature is approximately 60 to 62 degrees Fahrenheit (°F). The coldest month in the Oklahoma City area is typically January, with a mean temperature of 37°F. Extreme low temperatures below 0°F have been recorded. The hottest months are normally July and August, with mean temperatures of 81°F. Extreme high temperatures up to 113°F have been recorded. Temperature, precipitation, and other relevant data for the Tinker AFB site are presented in Table 2.1. The indicated period of record is 30 years.

The maximum monthly average precipitation of 5.18 inches for the Oklahoma City area occurs in May. Precipitation decreases in June, setting the stage for hot and dry summers. Average annual precipitation for the area is 33 inches. Mean annual snowfall is approximately 9-10 inches. Annual lake evaporation for the area is estimated to be 60 inches; thus, Tinker AFB is located in a water-deficient zone of the United States. Precipitation events releasing as much as 6.2 inches of rainfall in a 24-hour period have been reported, causing local flooding (NOAA, 1977).

Winds in the Oklahoma City area are variable, prevailing from the south. The average wind speed is 14 miles per hour (mph), and the annual percent of calm winds is 2.05. A wind rose for the Oklahoma City area, indicating wind speed, direction, and percent calm, is presented as Figure 2.4.

Mean relative humidity varies from 54 to 79 percent. Humidities in January range from 62 to 79 percent; in April, from 50 to 76 percent; in July, from 49 to 80 percent; and in October, from 57 to 79 percent. Normal atmospheric pressure is 1,016 millibars, or 30 inches of mercury, at 0 degrees Celsius (°C).

2.2.3 Geology

2.2.3.1 Regional Geology

Tinker AFB lies atop a column of sedimentary strata that is several thousand feet thick. The strata are primarily marine in origin and range in age (oldest to youngest) from Cambrian to Permian above a pre-Cambrian basement. Some Quaternary alluvium and terrace deposits can be found in and near present-day streams. Figure 2.5 shows the general near-surface stratigraphy in the vicinity of Tinker AFB.

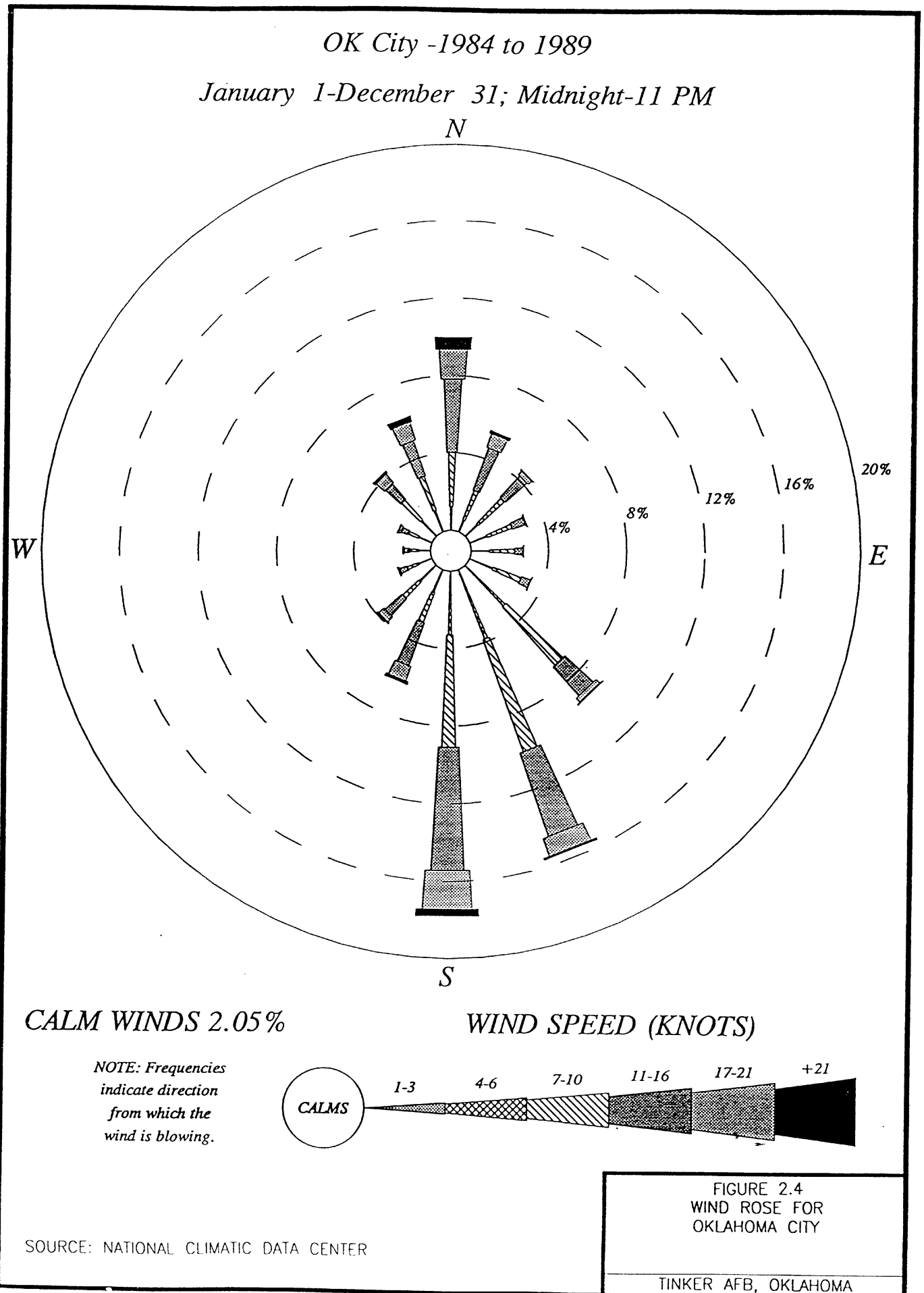
The surface soils of the installation area are of two predominant types: residual and alluvial. The residual soils associations, Darnel-Stephenville and Renfrow-Vernon-Bethany, are the product of the weathering of underlying bedrock. The alluvial soil association, Dale-Canadian-Port, consists of stream-deposited silts and sands whose occurrence is typically restricted to floodplains of area streams. Geologic units which outcrop at various locations within the Tinker AFB region are

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Table 2.1
Summary of Weather Data
Tinker AFB, Oklahoma

Mo.	Temperature Normal Daily Ranges			Mean Monthly Total Rainfall (Inches)	Fastest Wind Speed (mph)	Originating Wind (Direction)
	Min. (°F)	Avg. (°F)	Max (°F)			
JAN	27	37	46	1.5	63	West
FEB	30	41	51	1.64	61	West
MAR	37	48	60	2.09	61	South
APR	48	59	70	3.41	75	Northwest
MAY	58	67	77	5.18	72	Southeast
JUN	67	77	86	4.32	87	North-Northwest
JUL	70	81	92	3.03	73	Northwest
AUG	70	81	93	2.7	56	South
SEP	62	73	85	3.3	54	Northwest
OCT	51	62	73	2.82	65	South
NOV	37	48	59	1.9	66	South
DEC	30	40	49	1.43	56	Northwest
Overall Avg.	49	60	70	2.76	66	-
Total	-	-	-	33.14	-	-

Sources: *Climatic Atlas of the United States*, US Department of Commerce, Environmental Science Services Administration, Environmental Data Service, June 1968, National Oceanic and Atmospheric Administration (NOAA), 1977; *Off Base Groundwater Investigation Report Northeast of Tinker Air Force Base*, US Army Corps of Engineers, Tulsa District, Volume I Report; *Description of Current Conditions*, December 1992.



		THICKNESS (FEET)		DESCRIPTION
QUATERNARY	HOLOCENE	ALLUVIAL DEPOSITS	0-15	SAND, SILT, CLAY, AND LENTICULAR BEDS OF GRAVEL.
	PLEISTOCENE	TERRACE DEPOSITS	0-15	
PERMIAN	HENNESSEY GROUP	KINGMAN SILTSTONE	0-30	ORANGE-BROWN TO GREENISH GRAY, EVEN-BEDDED SILTSTONES WITH SOME FINE-GRAINED SANDSTONE AND RED-BROWN SHALE.
		FAIRMONT SHALE	0-30	RED BROWN BLOCKY SHALE.
	SUMNER GROUP	GARBER SANDSTONE	900	MOSTLY ORANGE-BROWN TO RED-BROWN FINE-GRAINED SANDSTONE, IRREGULARLY BEDDED WITH RED-BROWN SHALE AND CHERT AND MUDSTONE CONGLOMERATE.
		WELLINGTON FORMATION		RED-BROWN SHALE AND ORANGE-BROWN FINE-GRAINED SANDSTONE, CONTAINING MUCH MAROON MUDSTONE CONGLOMERATE AND CHERT CONGLOMERATE.
PENNSYLVANIAN AND OLDER UNITS				

FIGURE 2.5
GENERALIZED STRATIGRAPHIC
COLUMN OF
TINKER AFB

TINKER AFB, OKLAHOMA

composed of Quaternary alluvium and terrace deposits, the Hennessey Group, and the Permian Garber-Wellington Formation. Quaternary alluvium, present along portions of Crutch Creek and Soldier Creek, consists of unconsolidated, interfingered lenses of sand, silt, clay, and gravel. The terrace deposits, which were deposited by ancient streams, consist mostly of lenticular beds of sand, silt, clay, and gravel.

The two primary rock units that outcrop at Tinker AFB are the Permian-age Garber-Wellington Formation and the Hennessey Group. The Garber-Wellington Formation, estimated to be approximately 900 feet thick in the Tinker AFB area, consists of lenticular and interbedded sandstone, shale, and siltstone. Sandstone is orange-red to reddish-brown, fine-grained, and poorly cemented. The grains are sub-angular to sub-rounded and composed of quartz. Shale is reddish-brown and silty.

The Garber-Wellington is overlain by the Hennessey group over the southern half of the base. The Hennessey group consists of reddish-brown shale with beds of siltstone and silty sandstone. A veneer of the Kingman Siltstone and the Fairmont Shale covers the southeast portion of the base, separating surface soils from the underlying Garber Sandstone. However, observations during geotechnical investigations and monitoring well installation at the base indicate that these formations are thin or discontinuous. Figure 2.6 is a geologic map showing the outcrop area of the Garber-Wellington formation and Hennessey group.

The Permian strata exposed at the surface across Tinker AFB were deposited along a low-lying, north-south-oriented coastline. Land features included meandering to braided, sediment-loaded streams that flowed generally westward from the ancestral Ozark Mountains to the east. Sand dunes were common, as were cut-off stream segments that rapidly evaporated. The climate was arid, and vegetation was sparse. Offshore, the sea was shallow and deepened very gradually to the west. The shoreline position varied over a wide range. Isolated evaporite basins frequently formed as the shoreline shifted.

This depositional environment resulted in an interfingering collage of sands, clays, shallow marine shales, and evaporite deposits. The overloaded streams and evaporitic basins acted as sumps for heavy metals such as iron, chromium, lead, and barium. Oxidation of iron in the arid climate resulted in the reddish color of many of the sediments. Erosion and chemical breakdown of granitic rocks from the highlands resulted in extensive clay deposits. Evaporite minerals, such as anhydrite, barium, and gypsum, were commonly deposited. Only very fine-grained material reached the marine environment, resulting in thin but widespread layers of shale and siltstone, interspersed with occasional coarser-grained sandstone lenses.

2.2.3.2 Site Geology

Past and current investigations performed at the WWTF indicate that the stratigraphy beneath the site is characterized by interbedded, discontinuous units of sandstone, siltstone, and shale varying in thickness from 1 to 30 feet. The depth to rock ranges from 5.5 feet to 15 feet across the site with no apparent trend (Tulsa Corps of Engineers [COE], 1991). The Hennessey shale is absent at the WWTF.

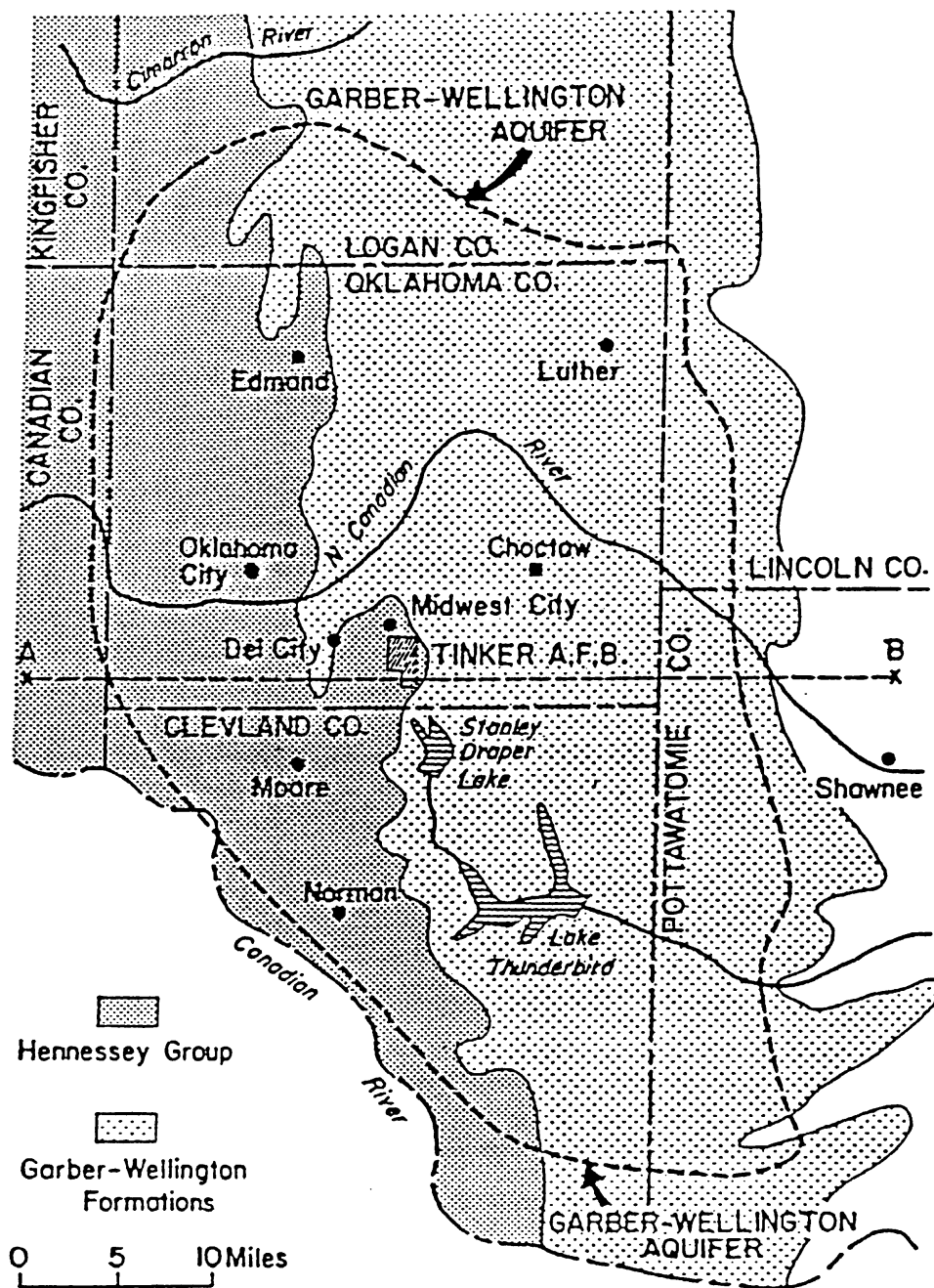


FIGURE 2.6
GEOLOGIC MAP OF
GARBER-WELLINGTON AND
HENNESSEY FORMATIONS

TINKER AFB, OKLAHOMA

SOURCE: Building 3001 Remedial Investigations Report,
Tinker Air Force Base, U.S. Army Corps of Engineers, Tulsa District,
January 1988.

2.2.4 Groundwater Hydrology and Use

Tinker AFB currently obtains its water supply from a distribution system composed of twenty-nine water wells constructed along the eastern and western base boundaries, and from the Oklahoma City Water Department. All base wells are completed in the Garber-Wellington, a section of the Central Oklahoma Aquifer. Base wells range in depth from 480 to 750 feet, with discharge yields ranging from 205 to 250 gallons per minute (gpm). The wells are completed with multiple screened intervals, deriving water supplies from sandstone zones varying in thickness from a few feet to 40 feet. Total screen lengths in the wells extend from 103 to 184 feet (ES, 1993a).

The nearby communities of Midwest City and Del City derive water supplies both from surface sources and wells tapping the aquifer. Industrial operations, individual homes, farm irrigation, and small communities not served by municipal distribution systems also depend on the Garber-Wellington section of the aquifer. Communities (such as Oklahoma City) currently depending upon surface supplies also maintain well systems drilled into the Garber-Wellington as a standby source of water in the event of drought.

Tinker AFB lies within the limits of the Garber-Wellington Groundwater Basin. The Garber Sandstone and the Wellington Formation are considered to be a single aquifer and provide the most significant source of potable groundwater supplies in the Oklahoma City area. The aquifer supplies much of the drinking water for the residents of Oklahoma and Cleveland counties (Tulsa COE, 1991). The average depth to water in the producing zone (deeper sandstone strata) of this aquifer is approximately 250 feet.

The Garber Sandstone and the Wellington Formation tend to vary in thickness over relatively short horizontal distances (Wood and Burton, 1968). The sediments that comprise the aquifer tend to be loosely cemented and have a maximum thickness of 1,000 feet. In the area of outcrop, groundwater occurs under water table (unconfined) conditions and may occur at relatively shallow depths below the ground surface (60 to 100 feet). In areas overlain by younger geologic units, wells must be drilled deeper (200 to 250 feet), and groundwater occurs in the aquifer under confined conditions (ES, 1993a). Water in the Garber-Wellington is normally encountered at a depth of 60 to 80 feet at Tinker AFB. Although most of the aquifer is believed to be saturated, wells are usually constructed with multiple screened intervals in order to obtain water from the more productive zones.

Recharge of the Garber-Wellington Aquifer is accomplished principally by rainfall infiltration and by percolation of surface waters crossing the area of outcrop. Most of Tinker AFB is located in an aquifer outcrop area (Figure 2.5), and as such is situated in a recharge zone (ES, 1993a). The aquifer, therefore, is susceptible to contamination in the study area. Although flow in the Regional Aquifer Zone is to the southwest, locally at Tinker AFB, groundwater flows to the northwest and south.

Groundwater occurs above the producing zone in what is known as the Regional Aquifer Zone (ES, 1993a). This groundwater zone generally occurs within the upper sandstone strata of the Garber-Wellington Formation. The hydraulic

gradient within this aquifer is generally to the southwest. The average depth to water in the Regional Aquifer Zone is approximately 50 feet.

Where present, the Hennessey group separates the regional water table in the Garber-Wellington from overlying perched water. Several wells in the area produce minor amounts of water from thin sandstone beds or from joints and fractures in the shale of the Hennessey Formation.

Shallow aquifers exist temporarily in zones of alluvium that border streams, or where sandy residual soils overlie bedrock at shallow depths. Soil aquifers are typically recharged directly by precipitation, gradually running dry seasonally as base flow to local streams and recharge to underlying rock aquifers deplete limited supplies. The significance of shallow aquifers is that they may act as pathways for contamination migration to important lower aquifers or to surface waters. However, the localized nature and ephemeral character of shallow aquifers make the detection of groundwater contamination problems difficult.

The quality of groundwater derived from the Garber-Wellington Aquifer is generally good, although wide variations in the concentrations of some constituents are known to occur (Wood and Burton, 1968; ES, 1993a). Wells drilled to depths greater than 900 feet may encounter a saline zone.

Past base activities in building 3001 have resulted in contamination of the upper groundwater zones of the Garber-Wellington aquifer with industrial solvents, metals, and fuel products. The primary contaminants in the vicinity of building 3001 are trichloroethene (TCE) and chromium. In 1987, the EPA placed the building 3001 site on the NPL of hazardous waste sites. In addition, the WWTF area, Soldier Creek, and various landfill sites on and off the base have undergone and are currently undergoing remedial investigations (RIs). As a result of these investigations, groundwater contamination is known to exist beneath base property.

Investigations were conducted in 1991 in areas north and east of Tinker AFB to determine if contamination found in off-base private water supply wells originated from Tinker AFB sources. It was found that eight of the twenty-six private wells investigated had concentrations of chlorinated solvents above the detection limits. The primary contaminants encountered were 1,2-dichloroethane, tetrachloroethene (PCE), and TCE. Tinker AFB contracted the US Army Corps of Engineers (COE) to install and test a network of off-base monitoring wells to determine if any possible linkage could be established to on-base sources.

Analysis of groundwater elevations and contamination data from the off-base wells installed by the COE indicates that other sources of groundwater contamination exist in the off-base areas. "Fingerprint" analyses of detected compounds, coupled with groundwater flow patterns, provided evidence that the off-base wells are contaminated with several organic chemicals which are not found in monitoring wells on base (Tulsa COE, 1991). In most cases, the off-base contaminants were primarily components of gasoline, such as benzene, toluene, ethylbenzene, and xylene (BTEX). There are several possible sources of the off-base contamination, as the area contains many businesses that have historically stored or used hazardous materials and/or wastes.

2.2.5 Surface Water

Tinker AFB has several streams and surface drainage systems which originate on or flow through the base property. Drainage from Tinker AFB is generally north to the North Canadian River via three primary watersheds: Crutch Creek, Kuhlman Creek, and Soldier Creek. The northeast portion of the base is drained primarily by unnamed tributaries of Soldier Creek, which is a tributary of Crutch Creek. A tributary of East Soldier Creek runs northeast through the WWTF and receives permitted discharges from the IWTP, SWTP, and stormwater runoff outfalls. The north and west sections of the base, including the main instrument runway, drain to Crutch Creek. Two small unnamed intermittent streams crossing installation boundaries south of the main instrument runway generally do not receive significant quantities of base runoff because of site grading designed to prevent such drainage. Several intermittent streams, when flowing, discharge into Lake Stanley Draper, approximately 0.5 mile south of the base, which is a source of drinking water for Oklahoma City.

The surface waters named above have been monitored routinely at several locations by the Tinker AFB Bioenvironmental Engineering Office (SGB). In addition, special sampling studies have been conducted by the US Geological Survey (USGS), Oklahoma Water Resources Board, and by Frank. During the summers of 1990 and 1991, surface water was sampled by Black and Veach on the east and west branches of Soldier Creek. Another stream sampling project was completed by Haliburton NUS in May 1992 on Crutch, Kuhlman, and Elm Creeks. The data obtained during these sampling events are discussed in the following paragraphs by sub-basins.

2.2.5.1 Crutch Creek

Crutch Creek and its tributaries traverse the southern and western portions of the base (Figure 2.2). Water quality data collected by the USGS during 1963 revealed lead values of 45 micrograms per liter ($\mu\text{g/L}$). Data collected from Crutch Creek in 1968 (ES, 1993a) indicated concentrations of total chromium ranging from 50 to 1,800 $\mu\text{g/L}$ and concentrations of cadmium ranging from 80 to 300 $\mu\text{g/L}$. Data collected by the SGB in 1980 indicated the levels of chromium were typically below 50 $\mu\text{g/L}$ (the detection limit of the test procedure used). Cadmium concentrations for Crutch Creek were consistently below 10 $\mu\text{g/L}$ during 1980.

Metals detected in samples collected in May 1992 were arsenic at 2.5 $\mu\text{g/L}$, barium at 1,040 $\mu\text{g/L}$, and zinc at 11 $\mu\text{g/L}$. No SVOCs were found above detection limits. Except for two that were determined to result from laboratory contamination, all VOCs were also below detection limits. No pesticides, herbicides, or PCBs were found.

2.2.5.2 Kuhlman Creek

Kuhlman Creek originates on Tinker AFB from surface drainage and stormwater runoff and drains the north-central portion of the base (Figure 2.2). The 1963 USGS data revealed chromium values of 129 $\mu\text{g/L}$ and cadmium values of 26 $\mu\text{g/L}$. The 1980 data showed iron concentrations from 0.12 to 3.1 $\mu\text{g/L}$ and manganese

concentrations from <0.050 to 4.5 mg/L. Oil and grease were detected in some 1980 samples.

No metals or organics were found above detection limits in the May 1992 samples. The pesticide Dursban was detected at 6.1 µg/L in one sample, apparently a result of surface runoff from a nearby storage building that had recently been treated for insect control. No herbicides or PCBs were found.

2.2.5.3 West Soldier Creek

West Soldier Creek originates on Tinker AFB and drains the northeast portion of the base. The 1963 USGS investigation revealed high metals content in water from the creek. Cadmium concentrations were in the range of 46,000 µg/L, and chromium concentrations were in the range of 31,000 µg/L. Aluminum, iron, manganese, and nickel were also analyzed; their respective concentrations were 620 µg/L, 540 µg/L, 1,400 µg/L, and 242 µg/L. These elevated metals concentrations may have originated from direct discharge of industrial wastes and spillage into the stream. In 1968, the surface water discharge was found to contain chromium and cadmium concentrations of 7,200 µg/L and 2,000 µg/L, respectively (ES, 1993a). The 1979 SGB data indicated that a significant decrease in chromium and cadmium concentrations had occurred in the creek. Occasionally, elevated levels of oil, grease, and phenol have been detected.

Several metals were detected in surface water samples from West Soldier Creek collected in 1990, including arsenic, barium, chromium, cadmium, nickel, and silver. All were determined to be consistent with background values. VOCs detected included methylene chloride, chloroform, acetone, and 1,2-dichloroethane at 14 µg/L. The source of the contamination was suspected to be the adjacent north-south main runway. Concentrations were generally higher on-base than off-base. SVOCs were detected; the highest concentration was for bis(2-ethylhexyl)phthalate at 8 µg/L. No trends or sources could be established.

2.2.5.4 East Soldier Creek

East Soldier Creek originates on Tinker AFB and drains the eastern portion of the base (Figure 2.2). The IWTP and SWTP currently contribute the majority of the creek's flow. The 1963 USGS investigation revealed chromium concentrations of 2,950 µg/L and cadmium concentrations of 2,180 µg/L. Nickel and manganese were detected at 129 µg/L and 58 µg/L, respectively. Samples collected by the University of Oklahoma in 1968 were found to have chromium concentrations ranging from 200 µg/L to 6,500 µg/L, and iron concentrations ranging from 0.44 mg/L to 14 mg/L.

SGB data collected in 1980 showed consistently high concentrations of total chromium. However, hexavalent chromium, the valence state considered to be toxic, was consistently below the primary drinking water standard of 50 µg/L. Cadmium concentrations were at or below the 10 µg/L drinking water standard. Nickel was the only parameter that was consistently detected at levels higher than the EPA ambient water quality criterion of 13.4 µg/L.

Several metals were detected in samples collected in 1990 and 1991, including arsenic, barium, chromium, cadmium, nickel, and silver. The concentrations were determined to be consistent with background concentrations. Several VOCs were detected, including methylene chloride, acetone, chloroform, perchloroethane, and toluene. Concentrations ranged from a maximum of 6 $\mu\text{g/L}$ on-base to 60 $\mu\text{g/L}$ off-base. It was concluded that the much higher off-base contamination was a result of off-base sources. Three SVOCs were detected, the highest concentration of which was bis(2-ethylhexyl)phthalate at 14 $\mu\text{g/L}$. No trends or sources could be established for these concentrations.

2.2.5.5 Elm Creek

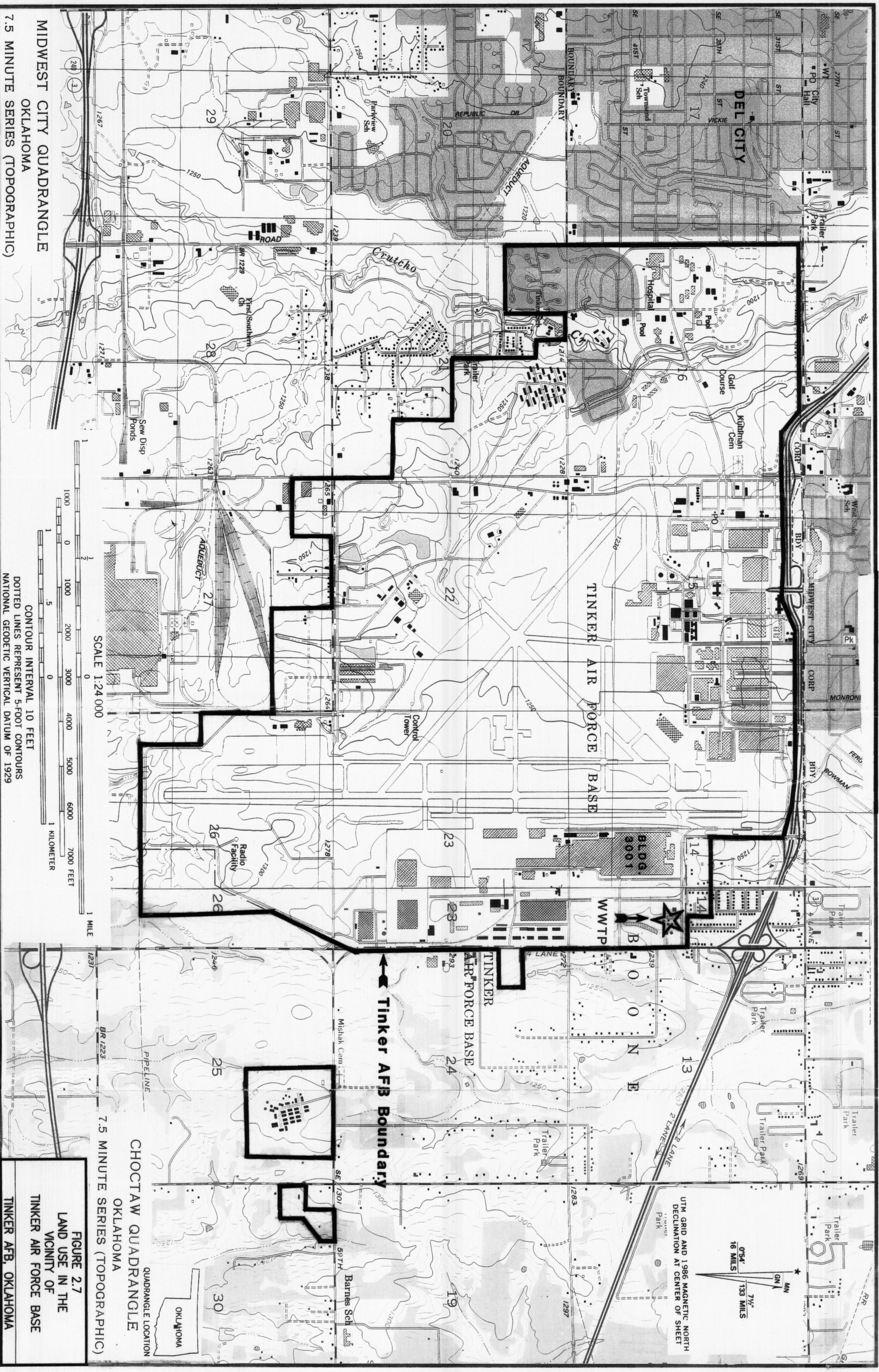
Elm Creek is located on the southernmost end of the base and flows southward to Lake Stanley Draper (Figure 2.2). Analysis of one sample from Elm Creek detected the element vanadium at 10 $\mu\text{g/L}$ during a May 1992 sampling project. No organics, pesticides, herbicides, or PCBs were found.

2.2.6 Land Use

Tinker AFB lies within an area representing a transition from residential and industrial/commercial land use on the north and west, to agricultural land use to the south and east. The base is surrounded by three municipalities: Del City on the northwest; Midwest City on the north; and Oklahoma City on the east, south, and southwest, as shown on Figure 2.7. Del City and Midwest City are heavily populated commercial and residential districts. Much of the area surrounding Tinker AFB, however, is devoted to agricultural or light residential use. One exception is the General Motors automobile plant, which lies south of the central part of the base. The General Motors complex includes a large manufacturing building, a wastewater treatment plant, parking lots for employees and for newly built automobiles, and a multi-branched railhead for in-shipment of parts and out-shipment of new automobiles.

The north end of Lake Stanley Draper, a large recreational and water supply reservoir, lies about 0.5 mile south of the southeastern corner of Tinker AFB. A small portion of its drainage basin lies within Tinker AFB boundaries.

Tinker AFB has continued to grow throughout its existence. In 1941, the base consisted of 960 acres donated by Oklahoma City. During the 1990s, a 15-acre area adjacent to the WWTF was purchased for use as a central computer facility and a child care center. Also purchased was a 13-acre area for a new engine fuel control and accessory test facility. Tinker AFB currently covers 4,541 acres. The base also leases 486 acres of adjacent land for various uses, including runway easement, landfills, and training exercises. Thus, a total of 5,003 acres of land is currently under Tinker AFB jurisdiction.



2.2.7 Demographics

Tinker AFB is located in Oklahoma County, which had a population of 628,600 in 1988, and within the city limits of Oklahoma City, the state capitol. The 1990 Census showed the population of Oklahoma City to be 444,710. The Oklahoma City Chamber of Commerce (1992) has projected the population of Oklahoma City to increase to 466,120 by the year 2000. Tinker AFB is located adjacent to Midwest City and Del City (satellites of Oklahoma City), which have populations of 58,000 and 33,400, respectively. The Oklahoma City metropolitan area population (including the satellite communities) is 958,839 (Census, 1990). The population of the state of Oklahoma is 3,145,585 (1992).

Tinker AFB employs approximately 22,750 people (Chamber of Commerce, 1992). This is more than 5 percent of Oklahoma City's population and more than 2 percent of the metropolitan area population. The base is the second largest employer in the area. The largest employer is the State of Oklahoma, which employs approximately 32,300 people. Other major employers include the University of Oklahoma (6,310), the Federal Aviation Administration (FAA) Aeronautical Center (6,026), the Oklahoma Health Center (5,922), AT&T (5,300), and General Motors (5,300).

2.2.8 Ecology

The following description of the ecology at Tinker AFB is based on information from the "F-16 Beddown Environmental Assessment," prepared by Argonne National Laboratories for Tinker AFB (Tulsa COE, 1988) and the Soldier Creek NPL Site Report (BVWST, 1993b).

Several federal threatened or endangered animal species may occasionally occur in the vicinity of Tinker AFB. Threatened species include the Arctic peregrine falcon and the piping plover. Endangered species include the bald eagle, American peregrine falcon, whooping crane, and the interior population of the least tern. The potential for the occurrence of these species in the immediate vicinity of Tinker AFB, however, is low because the preferred habitat and known areas of congregation for these species are not located near the base (Tulsa COE, 1988).

The most common species of birds which frequent the habitat types occurring at Tinker AFB are the killdeer, rock dove, mourning dove, Canada goose, common night hawk, chimney swift, scissor-tailed flycatcher, American crow, American robin, European starling, common grackle, and house sparrow. These species are common to the Oklahoma City area. Tinker AFB is located along the central flyways for migratory waterfowl (Tulsa COE, 1988).

Habitats most suited for wildlife occur primarily in mowed grassy fields and undeveloped/underutilized areas associated with drainages. Mammals which are common to habitat types occurring at Tinker AFB include the squirrel, thirteen-lined ground squirrel, eastern fox, plains pocket gopher, eastern cottontail rabbit, white-footed mouse, Norway rat, striped skunk, raccoon, opossum, and the house mouse (Tulsa COE, 1988).

Aquatic habitats occurring at Tinker AFB are creeks and ponds. The ponds are managed for largemouth bass and channel catfish fisheries. Other fish that might occur in these habitats include plains minnow, red shiner, black bullhead, bluegill, and green sunfish (Tulsa COE, 1988).

No endangered or threatened plant species have been reported in the Tinker AFB area (Township 11 North [T11N], Range 2 West [R2W], Oklahoma County). Three species of plants should be given special attention because of potential endangered or threatened species listing in the future. Within T11N, R2W, Oklahoma County, two populations of the Oklahoma beardtongue (*Penstemon oklahomensis*) were confirmed. A study is underway to determine if the Oklahoma beardtongue should be included on the US Fish and Wildlife Service's list of endangered or threatened species because of a decline in population due to loss of habitat. Two category 2 species for federal listing as endangered or threatened species include the Ozark poverty grass (*Sporobolus ozarkanus*) and a sedge (*Carex fissa*). This area is within the known range of these species, although no populations of Ozark poverty grass or the sedge have been confirmed within T11N, R2W, Oklahoma County (BVWST, 1993a).

One category 2 candidate species of insect for federal listing which is likely to occur in a habitat similar to that inhabited by the Oklahoma beardtongue is the prairie mole cricket (*Gryllotalpa major*). This species is currently unconfirmed in the area (BVST, 1993a).

Little natural habitat exists on-base, as most vegetated areas are mowed and landscaped. Varieties of grass present include bluestem, poverty grass, triple-awn, and Johnson. Scattered trees and shrubs occur around many buildings, the golf course, and on less-developed portions of the base. The largest wooded habitats occur along the watercourses. Woody species include oaks, elms, willows, cottonwoods, box elders, sycamores, redbuds, ashes, and sumacs (BVWST, 1993a).

2.2.9 Air Quality and Use

There are over 250 stationary air emission sources located at Tinker AFB. These emission sources currently operate in a "low requirements" regulatory structure that is afforded by Oklahoma County's status of attainment of current National Ambient Air Quality Standards (NAAQS). Most of the sources are "grandfathered," and the compliance requirements for them are satisfied by providing an annual emissions summary to the Oklahoma State Department of Health (OSDH). Sources that have been added to Tinker AFB's inventory of air pollution units since promulgation of permitting regulations are required to be subjected to OSDH scrutiny via "Permit to Construct" application submittals.

Permit processing, maintenance of permits, and conveyance of permit conditions to air emission source operators have been enhanced with the incorporation and use of the Air Quality Utility Information System (AQUIS). This new air program management system will help Tinker AFB manage the new requirements levied by the CAA Amendment of 1990, especially in regard to air toxics and the requirement to permit existing sources (grandfathering repealed). Generally, air

pollution sources are being operated and maintained in a manner that reduces the amount of emissions released to the environment.

The Directorate of Environmental Management at Tinker AFB is taking positive steps in regard to posturing for future regulatory requirements. Most notable is the undertaking of a comprehensive air toxics inventory, whereby levels of ambient toxins are assessed per source. The inventory also will detail the performance requirements of potential control measures. Air quality data collected during this RFI support these positive steps.

2.3 WASTEWATER TREATMENT FACILITY

The WWTF is located on 4 acres at the northeast corner of Tinker AFB (Figure 2.2) and consists of two separate treatment plants. The SWTP was originally constructed in 1943 for the treatment of sanitary wastewaters from the east side of Tinker AFB. From 1963 to 1971, the SWTP treated combined industrial and sanitary wastewaters; however, no industrial wastewater has been treated at the SWTP since 1971. It is currently used to treat approximately 465,000 gallons per day (gpd) of domestic wastewater (Tinker AFB, 1993). Seven SWMUs in the SWTP were identified during the RFA as areas requiring further investigation and are listed in Table 2.2.

The IWTP was constructed in 1963 for treatment of painting and stripping wastestreams. Several upgrades of the plant have occurred since the original construction. Industrial wastewater is collected in a segregated process sewer system that conveys the water to the IWTP. IWTP influent flow varies from 0.2 MGD to 1.4 MGD; however, an influent flow equalization system delivers a relatively constant flow of 0.8 MGD to the IWTP process units. The major sources of flow to the IWTP are maintenance processing (including electroplating, chemical cleaning, and paint stripping) and pretreatment of concentrated electroplating wastes. These operations generate wastewater contaminated with oil and grease, heavy metals, and organics (e.g., methylene chloride and phenols).

Ten lift stations are used to transport process water to the IWTP. A brief description of each lift station is given below.

1. Lift Station 2 is located at the headworks of the IWTP, inside a small concrete block pump house near the oil separator.
2. The lift station at building 3001 is located adjacent to the building along Staff Drive and has a lift-off rectangular cover.
3. The lift station at building 3221 is located on the east side of the building, north of the cooling tower, and has a round lift-off cover.
4. Lift Station 10 is located on the east side of building 3738 and near the north end of the building. The lift station has a hinged rectangular cover.
5. The lift station at building 2127 is located west of building 2128, between building 2128 and the wood shop building. Building 2127 is located south of building 2128. The lift station at building 2127 has a rectangular cover that is

Table 2.2
Solid Waste Management Units - Industrial and Sanitary Wastewater Treatment Plants
Tinker AFB, Oklahoma

SWMU No.	SWMU Name ¹
24	IWTP
24.1	Lift Station 2
24.2	Tanks D-1 and D-2
24.3	Oil Separator
24.4	Valve Vault
24.5	Equalization Basins
24.6	Main Flow Valve
24.7	Mixing Basins 1, 2, and 3
24.8	Solids Contact Clarifier
24.9	Wet Well Lift Station
24.10	Softener Basins
24.11	Activated Sludge Unit
24.12	Secondary Clarifiers
24.19	Industrial Sludge Drying Beds
32	SWTP
32.1	Parshall Flume
32.2	Flocculation Chambers
32.3	Primary Clarifiers
32.4	Trickling Filters
32.5	Final Clarifiers
32.6	Former Chlorine Contact Chamber
32.8	Drying Beds

¹ As designated in the RCRA Facility Assessment (RFA) Report (PRC, 1989).

located to the north of another rectangular cover and to the east of a round cover.

6. Old Lift Station 6 is located outside and adjacent to the main base fence along Douglas Boulevard, to the east of buildings 2122 and 2136. Old Lift Station 6 is located south of New Lift Station 6.
7. New Lift Station 6 is located north of Old Lift Station 6, outside and adjacent to the main base fence along Douglas Boulevard, and to the east of buildings 2122 and 2136.
8. The lift station at building 2211 is located to the west of building 2211, north of a nitrogen tower, and across a street (east) from building 2210. The lift station has a round hinged cover.
9. The lift station at building 2280 is located adjacent to the east side of building 2280, at the northern end, and south of an evaporation unit. The lift station has a rectangular lift-off cover.
10. Lift Station 3 is located on the west side of the base, between the southwest corner of building 214 and the intersection of B Avenue and 1st Street. The lift station has a rectangular hinged cover.

At the IWTP, the industrial wastewater is treated in unit processes that remove oil, grease, and heavy metals and oxidize biodegradable organic chemicals. Thirteen SWMUs in the IWTP were identified during the RFA as areas requiring further investigation and are listed in Table 2.2.

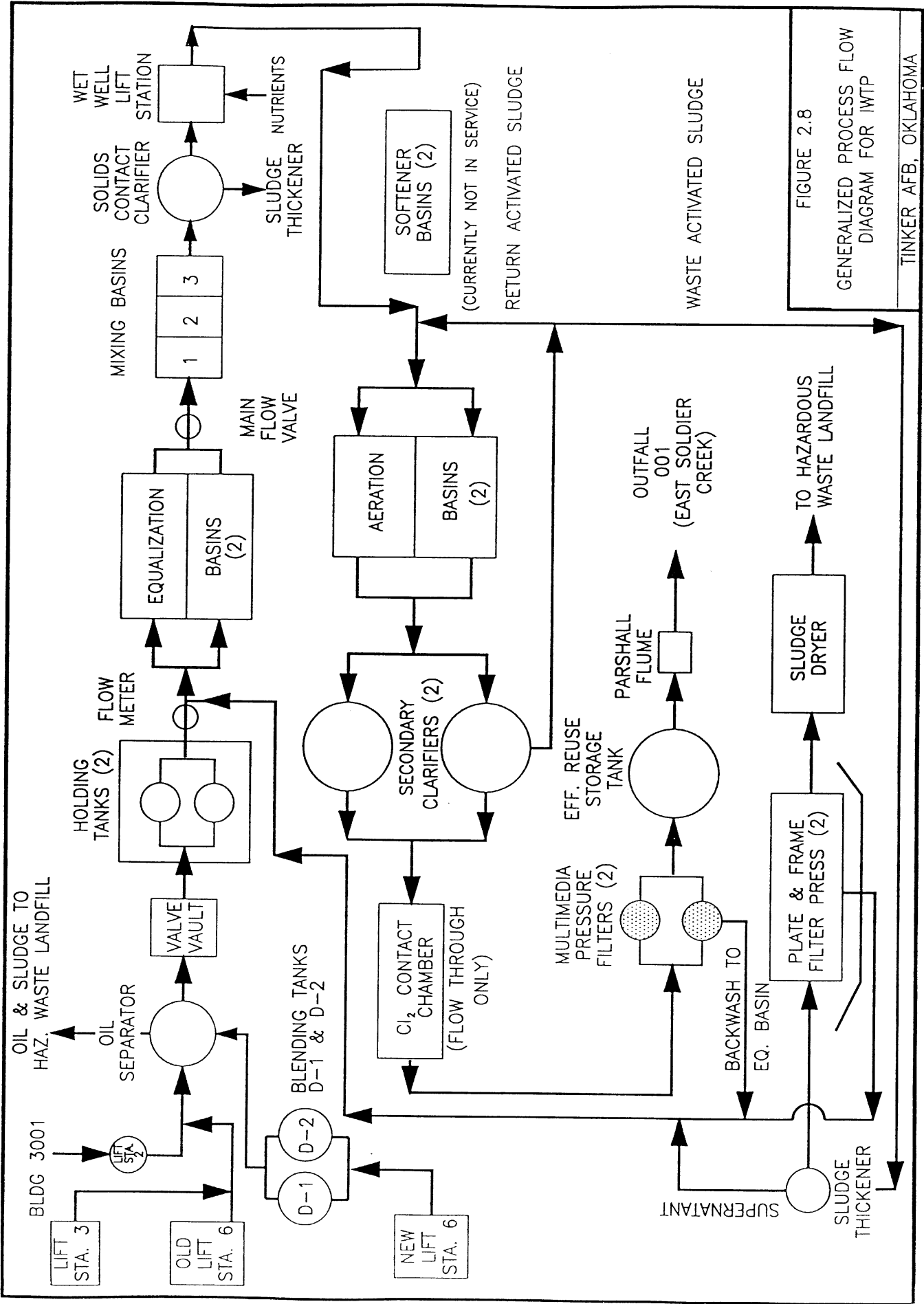
Both the IWTP and the SWTP operate under a NPDES permit, and discharge, along with storm water runoff, from ten outfalls into a tributary of East Soldier Creek. Previous investigations at the WWTF have confirmed groundwater contamination. The groundwater plumes beneath the WWTF and East Soldier Creek are considered operable units under the NPL listing of building 3001. Groundwater contamination at the site includes heavy metals, cyanides, VOCs, phenols, and various SVOCs. Domestic waste from the west side of Tinker AFB is discharged via a separate collection system into the Oklahoma City publicly owned treatment works (POTW). More complete descriptions of the IWTP and SWTP process units follow.

2.3.1 Industrial Wastewater Treatment Plant

The current flow scheme of the IWTP has been operational since 1971. A generalized process flow diagram of the IWTP is shown in Figure 2.8. A generalized description of the process flow is followed by more detailed descriptions of the individual treatment units.

2.3.1.1 Process Description

Industrial wastewater is conveyed to the IWTP via a series of lift stations and force mains. Four separate line systems combine to flow into the oil/water separator at the head of the plant. Gravity flow from the north and west sides of B3001 enter into lift station 2; lift station 3 transfers waste from the west side of the base; and the old lift station 6 line drains the majority of the south and east side of



the base. New lift station 6 discharges to blending tanks D-1 and D-2, and the blending tanks discharge to the oil/water separator. All four lines intersect approximately 40 feet west of the oil/water separator and enter into the tank.

The oil separator provides primary removal of oils and greases from the wastewater. Oil separator effluent flows over a weir into a sump serviced by two submersible pumps. Under normal operating conditions, the wastewater is pumped to one of two holding tanks. The wastewater leaving the holding tanks is directed through the valve vault and into the equalization basins. Wastewater can also be directed from the oil separator directly into the equalization basins. There are two equalization basins, each with two mechanical surface aerators. From the equalization basins, a main flow valve regulates flow to the mixing basins. Three mixing basins are operated in series, allowing the addition of chemicals (sodium sulfide, ferrous sulfate, sulfuric acid, and cationic polymer) which enhance metals removal from the wastewater.

From the mixing basins, the wastewater flows by gravity to the solids contact clarifier (SCC). Metals are precipitated in the SCC using anionic polymers which assist in particulate flocculation. The effluent from the SCC is transferred to the wet well lift station, where nutrients (ammonia and phosphoric acid) are added. The wastewater then flows to the activated sludge units. Softener basins, located between the wet well lift station and the activated sludge units, are completely offline, and the flow is routed around them to the activated sludge units. Soluble organics, primarily phenols, are removed from the wastewater in the aeration basins. Aeration and mixing are provided by blowers and static aeration.

Effluent from the activated sludge units flows by gravity to the secondary clarifiers. Most of the sludge collected at the bottom of the secondary clarifiers is recycled to the inlet of the aeration basins, but a small amount is wasted from the system and pumped to the sludge thickener. Clarified effluent flows by gravity from the secondary clarifiers to the chlorine contact chamber. The chlorine contact chamber is not currently used to oxidize or disinfect the wastewater, since it was determined that the chlorination step resulted in biotoxicity in the effluent.

Wastewater is pumped from the chlorine contact chamber to multimedia pressure filters. The pressure filters provide tertiary treatment of the wastewater prior to discharge or reuse. Effluent from the pressure filters discharges to a reuse storage tank, and backwash from the pressure filters is conveyed back to the equalization basins. The overflow from the reuse storage tank is discharged via a Parshall flume, which is used to measure the volume of treated industrial wastewater released to East Soldier Creek through the NPDES-permitted outfall 001.

Waste sludges from the SCC and the secondary clarifier are conveyed to the sludge thickener. The sludge thickener also receives sludges from other IWTP units, such as the equalization basins, on an annual basis. Thickened IWTP sludge is dewatered by two plate-and-frame filter presses and dried in a gas-fueled sludge dryer. Sludges produced at the IWTP were formerly dried in the now-inactive industrial sludge drying beds. The dried IWTP sludges are disposed of in a hazardous waste landfill.

2.3.1.2 Unit Descriptions

This section describes the SWMUs located at the IWTP, along with several units not designated as SWMU (not identified for investigation). A brief description is given for each unit, including its history, its capacity, and its present use.

Lift Station 2 (SWMU 24.1). Lift station 2 receives an industrial wastestream containing metals and organic compounds from chem cleaning located in the northwest section of building 3001. Other wastes from the plating shop enter from the west side of building 3001. These wastes are conveyed by gravity from building 3001 to lift station 2. Lift station 2 began operation in 1976 and is currently active. Wastewater is pumped from the lift station into the oil separator. Lift station 2 is located in a concrete building with a below-ground concrete-lined wet well. The sump contains three 1,100-gpm turbine pumps (two vertical and one submersible). The discharge from lift station 2 mixes with the discharges from blending tanks D-1 and D-2, lift station 3, and old lift station 6 as it enters the center well of the oil separator. No information is available on the depth of the excavation in which this unit was installed.

The building enclosing the lift station has a positive pressure ventilation system to prevent the accumulation of volatile gases. Air inside the building is exhausted by ventilation fans to the atmosphere outside the building.

Tanks D-1 and D-2 (SWMU 24.2). Tanks D-1 and D-2 have been used as blending tanks since the 1960s to segregate and temporarily store wastestreams that contain high concentrations of phenols. These two tanks are approximately 80 percent below grade and are located at the northwestern corner of the IWTP, with D-1 just north of D-2. These tanks receive wastewaters containing high concentrations of phenols from paint stripping operations within buildings 2280 and 2122 and the AWAC facility. Wastewater is pumped into tanks D-1 and D-2 from the new lift station 6.

Tanks D-1 and D-2 are each 60 feet in diameter with 12-foot sidewalls and flat bottoms. The tanks are constructed of concrete and each has a nominal capacity of 250,000 gallons. Each tank is open-topped with aeration piping located near its base. The blending tanks are operated in parallel, and a valve on the influent pipe allows the flow to be directed to either tank. The equalization line is valved so that the two tanks can be isolated. The retention time in tanks D-1 and D-2 is approximately 51 hours. The discharge rate to the oil separator is manually set to minimize phenol/chemical oxygen demand (COD) concentrations at the wet well lift station (SWMU 24.9, upstream of the activated sludge unit). The blending tanks can be valved to discharge to the downstream equalization system, but the normal discharge location is the oil separator. The sludge which accumulates in these tanks is removed annually and transported to a hazardous waste landfill. The depth of the excavation in which these tanks were installed is estimated to have been approximately 12 feet below grade.

Oil Separator (SWMU 24.3). The oil separator commenced operation in 1971 and provides primary removal of oils and greases. It is a single 60-foot-diameter, concrete, open-top tank. The unit is operated at a sidewall depth (SWD) of 9 feet

and has a capacity of 187,000 gallons. The flow to the oil separator is received from lift station 2, lift station 3, old lift station 6, and new lift station 6 (via Tanks D-1 and D-2). Influent enters the bottom center of the separator and flows upward through the center support pier and radially outward to the effluent well. The average retention time for the unit is 5.6 hours. The unit is a circular clarifier that works on the principle of gravity separation of liquids or solids from water because of differences in specific gravity. Oils with a specific gravity less than that of water rise to the surface and are trapped within a baffle. Oily sludges and solids with specific gravities greater than that of water sink to the bottom. The depth of excavation used to install this unit is assumed to be 12 feet below the surrounding grade.

The unit receives wastewater containing metals and organic compounds. Effluent leaving the oil separator flows over weirs into a sump. The separator includes a surface skimmer and rake mechanism to facilitate removal of floating and settled material. Both the skimmed and settled materials are deposited in an oil collection sump, transferred via a belt skimmer to transportable waste oil containers, and disposed of offsite at a hazardous waste landfill.

Valve Vault (SWMU 24.4). The original purpose of the valve vault was to direct wastewater flow into the equalization basins downstream. Historically, wastewater leaving the oil separator flowed by gravity through piping in the vault to the equalization basins. In 1990, holding tanks were built to mitigate influent flow surges to the equalization basins. Currently, wastewater leaving the oil separator flows through the valve vault into a transfer pump station which houses two 600-gpm submersible pumps. The submersible pumps discharge to the two holding tanks. Wastewater flowing from the holding tanks to the equalization basins is routed through the valve vault. The piping in the valve vault is valved so that discharge from the oil separator can flow directly into the equalization basins, bypassing the holding tanks, if needed. The valve vault is a below-ground, covered concrete structure. The depth of the excavation in which this unit was installed is approximately 12 feet below grade.

Holding Tanks (Non-SWMU). Flow is pumped from the transfer pump station associated with the valve vault to one of two 1.1-million gallon, above-grade, open top, steel holding tanks. Each tank is 76 feet in diameter with 35-foot sidewalls. These tanks were put into operation in December 1990. Each tank is mixed by a submersible, rail-mounted pump near the influent point. Holding tank effluent can either be pumped by a submersible, rail-mounted pump or allowed to flow by gravity to the equalization basins. The pumps are each rated at 900 gpm. The rate of effluent flow is regulated by a butterfly valve controlled from a panel in the control room. The purpose of the holding tanks is to minimize the variability of the flow discharged to downstream treatment units.

The holding tanks are batch operated, with one tank filling while the other tank is draining. Each tank is filled until it is approximately 85 percent full, and then is drained at a controlled rate while the other tank is filled. Influent flow to the tanks varies with the flow rate of building 3001 effluent, the flow from west end of the base, and the amount of paint-stripping wastewater added to maintain an acceptable phenol concentration. The average retention time in the tanks is approximately 30

hours. Flow from the holding tanks is measured with an in-line magnetic flow meter (magmeter). Sludge which accumulates in this unit is removed and disposed of in the sludge thickener on an annual basis. The depth of the excavation in which these tanks were installed is approximately 12 feet below the surrounding grade, including tank foundations and piping.

Equalization Basins (SWMU 24.5). The equalization basins were put into operation in 1971 to allow pH adjustment and to provide a consistent quality influent to the downstream metals removal units and activated sludge process. The basins typically receive wastewater from the oil separator by way of the holding tanks. A magmeter on the equalization basin effluent piping allows the operators to monitor flow.

The equalization basins are common-wall, rectangular concrete basins, each 100 feet long, 50 feet wide, and 10 feet deep. The capacity of each tank is approximately 375,000 gallons. Four mechanical surface aerators, two per basin, provide mixing in the open-top tanks. A caustic tank and caustic feed pump are located on the north-east side of the equalization basins. During filling, pH is checked and, if less than 7.2, is adjusted with caustic. Generally, the pH is greater than 7.2, so caustic additions are not normally required. The average retention time in the tanks is 11 hours. Sludge which accumulates in the equalization basins is removed annually and placed in the sludge thickener. The depth of the excavation in which these basins were installed is estimated to be less than 15 feet below grade, based on soil boring information.

Main Flow Valve (SWMU 24.6). Flow from the equalization basins to the mixing basins is regulated by the main flow valve. The main flow valve is a butterfly valve housed in a below-ground, closed-top concrete vault built in 1971. The vault is approximately 10 feet by 10 feet by 10 feet, and is covered at ground level by removable metal lids. The depth of excavation in which this unit was installed is estimated to be approximately 12 feet below grade.

Mixing Basins 1, 2, and 3 (SWMU 24.7). Chemicals are added in mixing basins 1, 2, and 3 to enhance removal of metals, primarily hexavalent chromium. The three mixing basins provide the chemical and physical environment needed for the reduction and coagulation of chromium and other metals. Polymer is added as a flocculation aid for the subsequent clarification process. All three basins are open-topped, below-ground features. Sludge accumulated in the units is removed on an annual basis and placed in the sludge thickener. The depth of the excavation in which the basins were installed is estimated to be 18 feet below grade.

Wastewater containing heavy metals, suspended solids, and organics enters the first of these three mixing basins (mixing basin 1) in which sodium sulfide is added as part of the hexavalent chromium-reduction process. Mixing basin 1 is a concrete tank, 14 feet long by 13 feet wide by 16 feet deep, which contains an axial flow impeller mixer. The capacity of the tank is approximately 15,600 gallons, and the average retention time is 28 minutes. The sodium sulfide feed rate is set manually, based on periodic analysis of hexavalent chromium in the equalization basins and the rate of influent flow to the mixing basins. Operators adjust the chemical feed

pumps based on tables that give the appropriate feed rate for various concentrations of hexavalent chromium and influent flow rates. Milton Roy LMI® feed pumps are used to feed the sodium sulfide to the basin via a 1-inch, Schedule 40 polyvinyl chloride (PVC) pipe. A temporary building was constructed around the chemical feed equipment because, at temperatures below 62°F, the sulfide solution was reportedly crystallizing, making it difficult to pump.

Mixing basins 1 and 2 share a common wall. Wastewater flows between them through a submerged opening in this common wall. The dimensions, capacity, and retention time of mixing basin 2 are the same as those of mixing basin 1. Basin 2 is mixed with a single-speed Lightning® propeller mixer. Ferrous sulfate is added with a Milton Roy LMI feed pump. Following the addition of the ferrous sulfate, the water immediately turns black or dark gray. Sulfuric acid is added for pH control in mixing basin 2, if required.

The common wall between mixing basins 2 and 3 forms a broad-crested weir, and wastewater flows over the wall from basin 2 into basin 3. Basin 3 is 9 feet by 9 feet by 10 feet deep. A cationic polymer is added in mixing basin 3 to neutralize the charge of precipitated particles. The amount of polymer added is based on a signal from a streaming current detector located in the effluent pipe of mixing basin 3. The device measures a parameter similar to the zeta potential, which is a measure of the charge condition of the wastewater. The system is designed to work with Betz® 1120 cationic polymer.

Solids Contact Clarifier (SWMU 24.8). The SCC was installed in 1971 to remove precipitated solids from the wastewater stream. The SCC receives treated wastewater containing heavy metals, suspended solids, and organics from mixing basin 3. The wastewater flows by gravity from mixing basin 3 to the SCC through an underground pipe.

The SCC is an open-top concrete tank 55 feet in diameter. The volume of the tank is approximately 250,000 gallons, and the unit is about 90 percent below grade. The depth of the excavation in which this unit was installed is estimated to have been 15 feet below grade. Influent enters the SCC via a mixing chamber (14 feet in diameter and 6 feet deep) in the center of the unit. Surrounding the mixing chamber is a flocculation skirt (18 feet in diameter at the top, 33 feet in diameter at the bottom, and 7 feet deep). Solids are recirculated through the center well by an internal recycle propeller and through an external pump. The average retention time of the SCC is 7.5 hours.

The SCC also includes a sludge rake and skimmer mechanism with a scum collection box. Anionic polymer (Betz 1195) is added to the center well of the SCC to assist in particulate flocculation, based on a turbidity reading of the effluent. Liquids flow under a scum baffle and over the peripheral collection weirs into the effluent trough. Sludge from the SCC is pumped to the sludge thickener.

The SCC is operated as an upflow sludge blanket clarifier. The depth of the sludge blanket is maintained between 9 and 11 feet. The sludge blanket provides filtration of fine particles that will not settle. Because the sludge blanket is maintained at such a thickness, there are only about 3 to 4 feet of clear water

(supernatant) above the top of the sludge bed. Sludge is periodically drawn off the bottom of the SCC based on the thickness of the sludge blanket. An operator uses a Sludge Judge® (a sludge measuring device) to determine when sludge should be withdrawn from the SCC.

Wet Well Lift Station (SWMU 24.9). Wastewater flows by gravity from the effluent trough of the SCC to the wet well lift station. The wet well lift station contains three level-controlled pumps designed to pump wastewater to the activated sludge unit at a flow rate equal to the clarified overflow from the solids contact clarifier. The wet well lift station is an open-top concrete basin that is approximately 90 percent below grade. The dimensions of the wet well are approximately 20 feet by 10 feet by 12 feet deep. The pumps maintain a depth of 3 to 9 feet in the wet well. The depth of the excavation in which this unit was installed is estimated to have been 12 feet below the surrounding grade.

The three pumps are Crane® centrifugal pumps with vertical-mounted motors. The pumps are rated at 2,280 gpm, 1,760 gpm, and 520 gpm. The pump motors are constant speed, and throttling is provided with a butterfly valve in the pump discharge line. The valve is controlled to maintain a constant water level in the wet well. Currently, only the 1,760 gpm pump is used for normal operations. The 2,280 gpm pump is rarely used because it cavitates when throttled. A nitrogen/phosphorus nutrient is currently added to the wastewater in the wet well lift station prior to discharge to downstream units.

Softener Basins (SWMU 24.10). The softener basins were originally constructed to soften the wastewater, but have been used primarily as an additional clarifier prior to the activated sludge system. The softener basins were added to the process stream in 1984 and are currently inactive. The softener basins are two side-by-side steel tanks, 62 feet long by 11 feet wide by 11 feet deep. The basins rest on a concrete pad that is level with the surrounding grade. When the basins were operational as a softening unit, solids settled to the bottom of the basins and were collected in a hopper. Currently, no flow enters this unit. The depth of the excavation in which this unit was installed was approximately 3 feet below the surrounding grade.

Activated Sludge Unit (SWMU 24.11). The activated sludge unit, more properly referred to as the aeration basins, provides for the removal of soluble organic substrates (primarily phenol) from the wastewater by the conversion of soluble organics into carbon dioxide, water, and carbohydrates by microorganisms. The result of this process is a reduction in the chemical and biochemical oxygen demand of the wastewater.

The aeration basins are two above-ground, common-wall, rectangular concrete tanks that are each 70 feet long by 20 feet wide. The basins are operated in parallel with an 18-foot SWD and 4 feet of freeboard. Each basin has a volume of approximately 190,000 gallons. Aeration and mixing are provided by a static aeration system consisting of centrifugal blowers and static diffusers located on 8-foot centers at the bottom of each basin. There are 24 coarse bubble diffusers in each basin. The basins are operated in a plug flow configuration with return activated sludge

(RAS) brought to the influent end of the basins and mixed with the influent wastewater in a static mixer. Equipment is in place to add both ammonia and phosphoric acid, if supplemental nutrients are needed. The average retention time in the aeration basins is 11.3 hours. The depth of the excavation in which this unit was installed is estimated to have been 15 feet below the surrounding grade.

Secondary Clarifiers (SWMU 24.12). There are two secondary clarifiers. The west clarifier has a diameter of 45 feet and a SWD of 12 feet. The east clarifier has a diameter of 55 feet and a SWD of 9.5 feet. Both clarifiers are open-top, concrete tanks built approximately 90 percent below grade. The west unit has a capacity of approximately 165,000 gallons and an average retention time of 12.3 hours. The east unit has a capacity of approximately 172,000 gallons and an average retention time of 8.6 hours. The depth of the excavation in which both clarifiers were installed is estimated to have been 15 feet below the surrounding grade.

The clarifiers are operated in parallel, with influent flow to each unit proportioned by a weir box at the outlet of the aeration basins. Each clarifier has two Allis-Chalmers® centrifugal dry-pit pumps to recycle the RAS to the influent of the aeration basins. Sludge is wasted on the basis of sludge age, as estimated by the mean cell residence time. The operations and maintenance manual states that the system is operated in extended aeration mode and that the mean cell residence time is maintained between 20 and 30 days, with a target of 25 days. Typically around 96 percent of the sludge collected at the bottom of the clarifiers is recycled to the aeration basins; the remainder is pumped to the sludge thickener. The supernatant (clarified liquid) from these clarifiers flows over weirs to the chlorine contact chamber.

Chlorine Contact Chamber (Non-SWMU). Effluent from the secondary clarifiers flows by gravity to the chlorine contact chamber, which is currently not used to oxidize or disinfect the wastewater. The chlorination step was eliminated when it was determined that it was causing biotoxicity in the effluent. The wastewater flows through the baffled chamber and is pumped by vertical turbine pumps to the pressure filters. The throttling of the pumps is controlled manually and must be adjusted when the plant flow changes. When it is necessary or desirable to bypass the pressure filters, effluent from the chlorine contact chamber can be pumped directly to the reuse storage tank downstream of the pressure filters.

The chlorine contact chamber has a nominal capacity of 49,000 gallons and an average retention time of 1.5 hours. Sludge which accumulates in this unit is sent to the sludge thickener on an annual basis. (Note: This is not the same chlorine contact chamber as in the SWTP. That unit, called the former chlorine contact chamber, is smaller in size and is an identified SWMU.) The depth of the excavation in which this unit was installed was approximately 14 feet below the surrounding grade.

Pressure Filters (Non-SWMU). Effluent from the chlorine contact chamber is pumped to multimedia pressure filters. The pressure filters were installed to provide tertiary treatment of the wastewater before discharge or reuse. The media used are garnet, silica sand, and anthracite coal installed in steel, horizontal pres-

sure vessels with unknown distribution piping. The garnet layer is 4.5 inches thick, the sand layer is 9 inches thick, and the coal layer is 16.5 inches thick. The vessels are 18 feet in length and 8 feet in diameter, and have a nominal capacity of 6,000 gallons each. The average retention time for the units is 8 minutes.

Backwash is initiated by an operator on a predefined schedule. The filters are not backwashed to completion because they perform poorly when completely clean. An air-scour system is installed but not used. There is sufficient head on the filtrate to convey it into the reuse storage tank. Backwash from the pressure filters is pumped to the equalization basins.

Reuse Storage Tank (Non-SWMU). The reuse storage tank (reclaim tank) is a coated steel vessel, 50 feet in diameter and 33 feet deep, located adjacent to the pressure filters. The reuse storage tank is an above ground tank. Treated effluent is stored in the reuse storage tank for use as process water at Tinker AFB's industrial facilities. The reuse storage tank also provides water for backwash of the pressure filters. Two vertical turbine pumps, each with a rating of 750 gpm, serve as feed pumps for backwashing the pressure filters. The treated effluent that is not reused is discharged into East Soldier Creek through a flow monitoring and sampling station (outfall 001). The depth of the excavation in which this unit was installed was 4 feet below the surrounding grade.

Sludge Thickener (Non-SWMU). The sludge thickener routinely receives sludge from the SCC and the secondary clarifiers. Sludge removed on an annual basis from the holding tanks, the equalization basins, the mixing basins, and the chlorine contact chamber are also thickened in the sludge thickener. The unit is constructed of concrete and has a diameter of 30 feet and a SWD of 9 feet. Its volume is approximately 47,000 gallons, and it has an average retention time of 50.3 hours. The clarified supernatant is returned to the equalization tanks, and the thickened sludge is discharged to the sludge handling building. The depth of the excavation in which this unit was installed is estimated to have been 11 feet below the surrounding grade.

Plate-and-Frame Filter Presses (Non-SWMU). Thickened sludge is dewatered by two JWI® plate-and-frame filter presses. The presses are housed in a sludge handling building at the northeast corner of the wastewater treatment facility, adjacent to the operator's building. Filtrate from the presses is assumed to be collected and discharged to the equalization tanks. The filter cake is sent to the sludge dryer. No information is available on the depth of the excavation that was required when the building which houses these units was constructed.

Gas-fueled Sludge Dryer (Non-SWMU). The gas-fueled sludge dryer receives dewatered sludge from the plate-and-frame filter presses. The residual product from the dryer is placed in roll-off boxes and disposed of offsite at a hazardous waste landfill. No information is available on the depth of the excavation in which this unit was installed.

Industrial Sludge Drying Beds (SWMU 24.19). This SWMU consists of six inactive sludge drying beds. Located in the southwestern corner of the IWTP, these beds were used from 1942 to 1971 for drying sludges generated during treatment of

industrial wastewaters. The beds are a set of six concrete cells constructed side by side, divided by 3-foot-high concrete walls. Each bed is about 15 feet wide by 120 feet long. The beds were reported to have been cleaned out prior to being taken out of service (ES, 1993a). The underground drain lines were constructed of vitrified clay pipe and perforated tile pipe, and these lines were removed when the unit was taken out of service. The depth of the excavation in which this unit was installed was approximately 8 feet below the surrounding grade, including the sump for the drain lines.

Prior investigations have theorized that these beds have contributed to the contamination of East Soldier Creek. It is uncertain if releases from this unit have been documented. Cracks in the concrete walls were noted during the 1989 inspection; however, the integrity of the concrete bottoms could not be determined because they were submerged by collected rainwater (ES, 1993a).

2.3.2 Sanitary Wastewater Treatment Plant (SWTP)

The SWTP (also referred to as the STP in some previous documents) is located at the same site as the IWTP. A generalized process flow diagram for the SWTP is shown in Figure 2.9. The following is a brief description of the process flow through the SWTP. More detailed descriptions of the individual treatment units are contained in subsection 2.3.2.2.

2.3.2.1 Process Description

Influent enters the SWTP via a coarse bar screen and Parshall flume. The Parshall flume empties into two parallel flocculation chambers. Ferric chloride is added to the wastewater in the flocculation chambers. From the flocculation chambers, the sanitary wastewater flows to the primary clarifiers for solids separation. The two primary clarifiers operate in parallel. Sludge removed from the wastewater in the primary clarifiers is pumped to the anaerobic digester.

Effluent from the primary clarifiers flows by gravity to two trickling filters. Wastewater percolates through the flint rock media in the filters to a collection system at the base of each filter. From the collection system, the trickling filter effluent flows by gravity to the two final clarifiers, which operate in parallel. Sludge from the final clarifiers is pumped back to the primary clarifiers. Effluent leaving the final clarifiers flows to the former chlorine contact chamber. The unit is no longer used for disinfection, as it was determined that the chlorination step caused biotoxicity in the effluent; however, the effluent still passes through the chamber. From the former chlorine contact chamber, the effluent is pumped through two multimedia pressure filters. The final effluent is discharged into East Soldier Creek through the permitted outfall 01S.

The sludges originating in the primary clarifiers and the flocculation chambers are treated in the anaerobic digester. Supernatant from the anaerobic digester is returned to the flocculation chambers. The stabilized sludges discharged from the

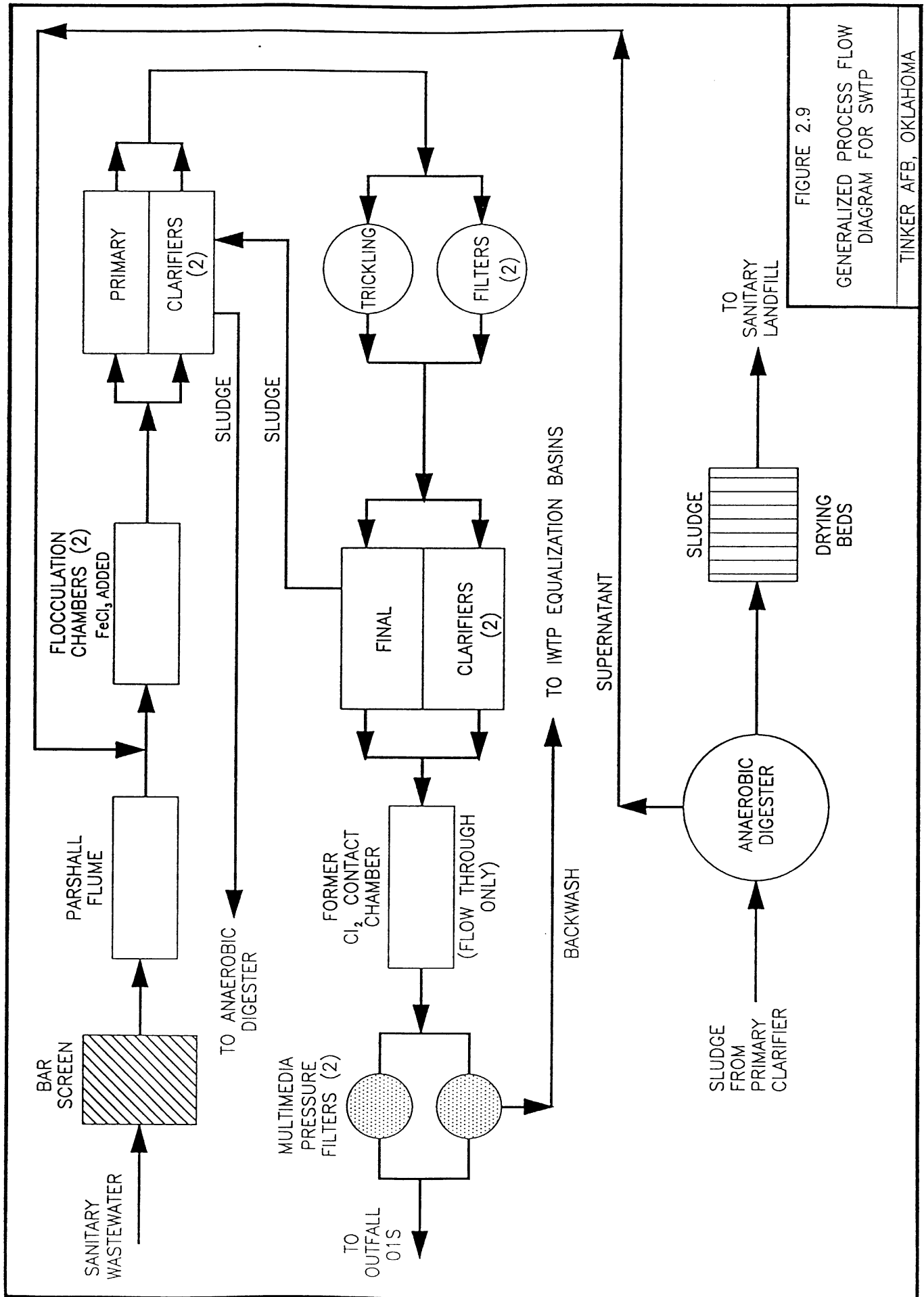


FIGURE 2.9
GENERALIZED PROCESS FLOW
DIAGRAM FOR SWTP
TINKER AFB, OKLAHOMA

anaerobic digester are dewatered in the drying beds (also known as the sanitary drying beds) located adjacent to the anaerobic digester. Sludge is dried in the beds for periods varying from 30 days to 6 months, depending on climatic conditions. After drying, sludges are removed from the drying beds and hauled offsite by contractors for disposal at a sanitary landfill.

2.3.2.2 Unit Descriptions

Parshall Flume (SWMU 32.1). This unit is used to measure influent flows to the SWTP. This unit was operated from 1963 to 1971 as part of the industrial wastewater treatment plant. From 1942 to 1963, and since 1971, the Parshall flume has been active as part of the sanitary wastewater treatment plant. The flume, below ground and constructed of concrete, is 16 inches deep and 52 inches long. The unit is covered by removable boards to provide access. Currently, only sanitary wastewater from the eastern area of the base flows through the flume and an accompanying bar screen, which removes debris from the influent to the SWTP. The bar screen precedes the flume. The depth of the excavation in which this unit was installed was approximately 2 feet below the surrounding grade.

Flocculation Chambers (SWMU 32.2). The flocculation chambers are below-grade, closed-top concrete tanks located inside building 62505. Flow from the bar screen and Parshall flume empties into the flocculation chambers. The flocculation chambers operated from 1963 to 1971 as part of the IWTP. Prior to 1963 and since 1971, this unit has been active as part of the SWTP. A ferric chloride polymer blend is added to the wastewater in the unit. The amount of polymer blend added depends on the concentration of influent suspended solids. The flocculation chambers have a volume of approximately 6,700 gallons. The depth of the excavation in which this unit was installed was approximately 12 feet below the surrounding grade.

Primary Clarifiers (SWMU 32.3). The primary clarifiers receive wastewater from the flocculation chambers. The primary clarifiers were operated from 1963 to 1971 as part of the IWTP. From 1942 to 1963 and since 1971, this unit has been active as part of the SWTP, and at present only sanitary wastewater is treated in the unit. The two rectangular primary clarifiers are open-top concrete tanks, each about 50 feet long by 10 feet wide by 10 feet deep. The units are operated in parallel. The capacity of each clarifier is approximately 45,300 gallons, and the average retention time is 4 hours. A flight mechanism is used to move settled solids to the far end of the clarifier. Sludge collected in the primary clarifiers is pumped to the anaerobic digester. The depth of the excavation in which this unit was installed was approximately 15 feet below the surrounding grade.

Trickling Filters (SWMU 32.4). Two trickling filters, operating in parallel, receive wastewater from the primary clarifiers via gravity. The trickling filters operated from 1963 to 1971 as part of the IWTP. Prior to 1963 and since 1971, the trickling filters have been used only to treat sanitary wastewater. These units are circular, open-top concrete tanks about 35 feet in diameter and 7 feet deep, containing 6 feet of flint rock media. The filters are 90 percent below grade. Wastewater is sprayed over the flint rock for biological treatment. Wastewater flows through the flint rock media to a collection system at the base of the filters. The volume of each

tank is approximately 74,500 gallons. The depth of the excavation in which these units were installed was approximately 12 feet below the surrounding grade.

The trickling filters were overhauled in October 1990 to resolve compliance difficulties at the SWTP. Repairs included cleaning and replacing portions of underdrain structure, replacing rock media, installing ventilation piping, and repairing valves. In addition, the distribution system for the filters has been replaced, resulting in improved performance for organic removal.

Final Clarifiers (SWMU 32.5). Two rectangular final clarifiers receive gravity-fed wastewater from the trickling filters. The unit formerly received both industrial and sanitary wastewater. Currently, only sanitary wastewater is treated in the final clarifiers. The clarifiers operate in parallel and share a common wall. The unit consists of two open-top, below-ground concrete tanks, each approximately 50 feet long, 20 feet wide, and 10 feet deep. The capacity of each clarifier is 50,900 gallons, and the average retention time is approximately three hours. Effluent leaving the clarifiers flows to the former chlorine contact chamber. Sludge collected in the clarifiers is pumped to the primary clarifiers. The depth of the excavation in which these units were installed was approximately 12 feet below the surrounding grade.

Former Chlorine Contact Chamber (SWMU 32.6). The original purpose of the former chlorine contact chamber, which shares a common wall with the final clarifiers, was to chlorinate treated industrial and sanitary wastewater. Since 1971, the unit has treated only sanitary wastewater. The addition of chlorine was eliminated because it was causing biotoxicity in the effluent. The former chlorine contact chamber is a below-ground, open-top concrete tank about 20 feet long, 8 feet wide, and 8 feet deep. The capacity of the unit is approximately 18,800 gallons, and the average retention time is 53 minutes. From the former chlorine contact chamber, wastewater was formerly discharged directly to East Soldier Creek. Two multimedia pressure filters were added in 1984, and the effluent from the former chlorine contact chamber is now pumped to these filters, and then discharged to East Soldier Creek via outfall 01S. Sludge that accumulates in the former chlorine contact chamber is removed periodically and returned to the primary clarifiers. The depth of the excavation in which this unit was installed was approximately 12 feet below the surrounding grade.

Pressure Filters (Non-SWMU). Wastewater from the former chlorine contact chamber is pumped to two multimedia pressure filters. These filters have a capacity of approximately 4,900 gallons each and an average retention time of approximately 9 minutes. Filter backwash is sent to the IWTP equalization basins (SWMU 24.5). The filtrate (treated effluent) is discharged into East Soldier Creek via outfall 01S. The depth of the excavation in which these units were installed was approximately 4 feet below the surrounding grade.

Anaerobic Digester (Non-SWMU). The anaerobic digester receives sludge from the primary clarifiers and the flocculation chambers. The unit is a reinforced concrete structure with a floating cover, conical bottom, sludge inlets and draw-offs, supernatant draw-off, overflow lines, and exterior gas lines. The sidewalls are earth-insulated. The anaerobic digester is 45 feet in diameter with a sidewall depth of

30 feet. The depth of the conical bottom is 4 feet, and the useful volume is approximately 360,000 gallons. The flow rate to the unit is approximately 5,750 gallons per day, and the maximum retention time is 63 days. The depth of the excavation in which the unit was installed was approximately 15 feet below the surrounding grade.

The supernatant from the anaerobic digester is discharged to the flocculation chambers. The digested solids are periodically discharged to the drying beds. The produced gas (primarily methane) is flared.

Drying Beds (SWMU 32.8). The drying beds are used to dewater sludges discharged from the anaerobic digester. The sludge drying beds are located north-east of SWMU 24.19, the industrial sludge drying beds. The unit consists of nine adjoining shallow concrete pits, each about 3 feet deep by 10 feet wide by 100 feet long. After drying, sludges from the drying beds are removed and disposed. Base representatives were not certain where sludges were disposed during the period 1942 to 1971. Currently, sludges from this unit are hauled offsite by contractors for disposal at a sanitary landfill. The tile underdrain system beneath the unit was constructed of vitrified clay and perforated tile pipe, and these lines were removed when the industrial sludge drying bed underground piping was removed. The depth of the excavation in which this unit was installed was approximately 4 feet below the surrounding grade.

Between 1942 and 1963, the drying beds handled sanitary waste sludges. The unit operated from approximately 1963 to 1971 as part of the IWTP. Since 1971, this unit has been active as part of the present SWTP. (Note: this unit is not the same as the industrial sludge drying beds, SWMU 24.19.) No known release controls are associated with the unit.

2.4 RCRA FACILITY ASSESSMENT

This section discusses the results of the RCRA Facility Assessment (RFA) findings at the SWMUs for the wastewater treatment facility. The RFA was performed in 1989 by PRC for EPA.

Lift Station 2 (SWMU 24.1). No surface water, soil staining, or other obvious signs of release were noted.

Tanks D-1 and D-2 (SWMU 24.2). Soil staining was noted. VOCs may also be released to the air because the tanks are open at the top.

Oil Separator (SWMU 24.3). Soil staining was noted. Surface water run-off across the stained soil areas is possible. VOCs may also be released to the air because the separator is open to the atmosphere.

Valve Vault (SWMU 24.4). The integrity of the valve vault could not be determined. No surface soil or surface water staining were noted, and releases to the atmosphere were not observed.

Equalization Basins (SWMU 24.5). No surface soil staining or discoloration were noted in the vicinity of the equalization basins. VOCs may be released to the air because the equalization basins are open at the top, and the wastestream contains VOCs and is agitated during the treatment process.

Main Flow Valve (SWMU 24.6). The integrity of the main flow valve could not be determined. No surface soil or surface water staining were noted and releases to the atmosphere were not observed.

Mixing Basins 1, 2, and 3 (SWMU 24.7). No surface soil or surface water staining or discoloration were noted in the vicinity of the mixing basins. VOCs and sulfides may be released to the air from the mixing basins, which are open at the top and are agitated during the treatment process.

Solids Contact Clarifier (SWMU 24.8). No surface soil or surface water staining or discoloration were noted in the vicinity of the solids clarifier. VOCs and sulfides may be released to the air from the SCC, which is open at the top.

Wet Well Lift Station (SWMU 24.9). No surface soil or surface water staining or discoloration were noted in the vicinity of the wet well lift station. VOCs may be released to air because the wet well lift station is open at the top and flow into the wet well is turbulent.

Softener Basins (SWMU 24.10). No surface soil or surface water staining or discoloration were noted in the vicinity of the softener basins. VOCs may be released to the air because the softener basins are open at the top.

Activated Sludge Unit (SWMU 24.11). No surface soil or surface water staining or discoloration were noted in the vicinity of the activated sludge unit. VOCs may be released to the air because the aeration basins are open at the top.

Secondary Clarifiers (SWMU 24.12). No obvious surface soil or surface water staining or discoloration were noted in the vicinity of the secondary clarifiers. VOCs may be released to the air because the secondary clarifiers are open at the top.

Industrial Sludge Drying Beds (SWMU 24.19). Prior investigations have theorized that these beds have contributed to the contamination of East Soldier Creek. It is uncertain if releases from this unit have been documented. Cracks in the concrete walls were noted during the 1989 inspection; however, the integrity of the concrete bottoms could not be determined because they were submerged by collected rainwater (ES, 1993a).

Parshall Flume (SWMU 32.1). No surface soil staining was documented.

Flocculation Chambers (SWMU 32.2). No surface soil staining was documented.

Primary Clarifiers (SWMU 32.3). No surface soil staining was documented.

Trickling Filters (SWMU 32.4). No surface soil staining was documented.

Final Clarifiers (SWMU 32.5). No surface soil staining was documented.

Former Chlorine Contact Chamber (SWMU 32.6). No surface soil staining was documented.

Drying Beds (SWMU 32.8). Cracks were observed in the concrete sidewall of the drying beds.

SECTION 3

RCRA FACILITY INVESTIGATION METHODS

3.1 GENERAL

This section describes methods for the RFI field work performed at the Tinker AFB WWTF between September and November 1993. The investigation was performed in accordance with procedures described in the work plan (ES, 1993b), which consists of the site investigation plan, the data collection quality assurance plan (DCQAP), and the health and safety plan.

Table 3.1 is a summary of the SWMU-specific investigative activities, consisting of a soil gas survey, surface soil sampling, stream sediment sampling, exploratory soil borings, and influent lift station sampling for chemical analysis.

As specified in the DCQAP, three levels of data quality were observed during the field investigation (ES, 1993b). The data quality levels are defined in the Data Quality Objectives Guidance Document (EPA, 1987). The levels can range from Level I (qualitative field data) to Level V (analysis in offsite laboratory using nonstandard methods). Levels I through III were used for this project.

Level I analytical protocol was used to qualitatively screen air in the breathing zone for health and safety purposes. Level I soil headspace analysis was used to select samples from soil borings to send to the laboratory for further analysis.

Level II analytical protocol was used in the soil gas survey. The field laboratory provided compound-specific, quantitative results. Level II was also used by the field laboratory for air monitoring to screen for VOCs.

Level III analytical protocol was used by the offsite laboratory for qualitative and quantitative chemical analysis of the soil, IWTP influent, and sediment samples. This level of data quality is acceptable for risk assessment use. The air sampling analyses protocol was equivalent to Level III.

Methods used during the RFI are described in the following subsections. Photographs of the investigation are presented in appendix E.

3.2 INFLUENT LIFT STATION SAMPLING

The influent lift station sampling program consisted of collecting two rounds of wastewater samples from each of ten lift stations which supply influent to the IWTP. The first round was collected on November 3 and 4, 1993; the second round of

Table 3.1
Summary of Field Activities, September – November 1993
Tinker AFB, Oklahoma

Location	Soil Gas Survey Points	Surface Soil Samples	Stream Sediment Samples	Soil Borings	Geo— physical Logs	Waste— water Samples	Air Samples
Industrial WTP							
SWMU 24.1	7	0	0	1	1	0	0
SWMU 24.2	26	4	0	7	7	0	0
SWMU 24.3	14	3	0	2	2	0	0
SWMU 24.4	0	0	0	1	1	0	0
SWMU 24.5	8	2	0	2	1	0	0
SWMU 24.6	4	0	0	1	1	0	0
SWMU 24.7	4	0	0	2	2	0	0
SWMU 24.8	9	0	0	4	4	0	0
SWMU 24.9	4	0	0	2	2	0	0
SWMU 24.10	6	0	0	5	5	0	0
SWMU 24.11	7	0	0	4	4	0	0
SWMU 24.12	12	0	0	6	6	0	0
SWMU 24.19	30	4	0	10	10	0	0
Recirculation pit	10	1	0	3	3	0	0
Lift Station 2	0	0	0	0	0	2	0
Bldg. 3221	0	0	0	0	0	2	0
Bldg. 3001	0	0	0	0	0	2	0
Bldg. 2280	0	0	0	0	0	2	0
Bldg. 2211	0	0	0	0	0	2	0
Bldg. 2127	0	0	0	0	0	2	0
Lift Station 3	0	0	0	0	0	2	0
Old Lift Station 6	0	0	0	0	0	2	0
New Lift Station 6	0	0	0	0	0	2	0
Lift Station 10	0	0	0	0	0	2	0
Sanitary WTP							
SWMU 32.1	4	1	0	3	3	0	0
SWMU 32.2	4	0	0	2	2	0	0
SWMU 32.3	4	1	0	4	3	0	0
SWMU 32.4	12	0	0	6	6	0	0
SWMU 32.5	3	0	0	3	3	0	0
SWMU 32.6	2	0	0	1	1	0	0
SWMU 32.8	25	4	0	18	18	0	0
East Soldier Creek	0	0	14	0	0	0	0
Air							
Ambient	0	0	0	0	0	0	1,002
Process Exposure	0	0	0	0	0	0	689
Source	0	0	0	0	0	0	581
Total	195	20	14	87	85	20	2,272

samples was collected on November 10 and 11, 1993. Lift station samples were analyzed for:

- Arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and zinc by Methods 6010, 7471, and 7761;
- VOCs by Method 8240;
- SVOCs by Method 8270; and
- Total petroleum hydrocarbons (TPH) by Method 8015 (modified California method).

A summary of the IWTP influent samples collected from the lift stations is presented in Table 3.2. Sample identification numbers are included in the summary.

3.2.1 Sample Collection Methods

All of the wastewater samples from the lift stations were collected with disposable Teflon® bailers suspended on a nylon string. Each bailer and length of nylon string were used to collect a single sample and were then discarded. Sample bottles were filled directly from the bailer. After the sample bottles were filled, the pH, conductivity, and temperature of the wastewater were measured and recorded in the field logbook.

After collection, the samples were stored on ice in coolers until all the samples for the event had been collected. The samples were then packed in ice for shipment to the analytical laboratory via overnight courier.

Sample collection was documented in the field logbook, and the sample custody was documented with chain-of-custody forms. The chain-of-custody forms accompanied the samples in shipment to the analytical laboratory. In addition, field sampling information was entered into the IRP Information Management System (IRPIMS), and an IRPIMS file was sent to the analytical laboratory with the samples.

3.2.2 Quality Assurance Samples

In addition to the lift station wastewater samples, a series of quality assurance (QA) samples was collected. The types of QA samples included trip blanks, equipment blanks, field duplicates, a matrix spike, and a matrix spike duplicate. A trip blank, analyzed for VOCs, was stored and shipped with the volatile organic analysis vials for the lift station samples and the other QA samples for each sampling event. A total of two trip blank samples were sent and analyzed.

One equipment blank was prepared for each sampling event by pouring American Society for Testing and Materials (ASTM) Type II water through an unused bailer. The equipment blanks were analyzed for the same parameters as the lift station samples.

One field duplicate sample was collected for each sampling event and analyzed for the same parameters as the lift station samples. The field duplicate samples were collected by filling a second set of sample bottles along with the bottles for the

Table 3.2
Lift Station Wastewater Influent Sample Summary
Tinker AFB, Oklahoma

Location	Sample Identification	Sample Type	Date of Collection	Time of Collection
Lift Station 2	IWTLS2	WW	11/3/93	1415
	IWTLS2	FD	11/3/93	1415
	IWTLS2	MS	11/3/93	1415
	IWTLS2	MSD	11/3/93	1415
Building 3221	IWTBG3221	WW	11/3/93	1615
Lift Station 3	IWTLS3	WW	11/4/93	0815
Lift Station 10	IWTLS10	WW	11/4/93	1035
Building 3001	IWTBG3001	WW	11/4/93	1140
Building 2280	IWTBG2280	WW	11/4/93	1330
Building 2211	IWTBG2211	WW	11/4/93	1415
Building 2127	IWTBG2127	WW	11/4/93	1510
New Lift Station 6	IWTLS6NEW	WW	11/4/93	1710
Old Lift Station 6	IWTLS6OLD	WW	11/4/93	1720
NA	EB1	EB	11/3/93	1345
Lift Station 2	IWTLS2	WW	11/10/93	1110
	IWTLS2	FD	11/10/93	1110
Lift Station 3	IWTLS3	WW	11/10/93	1110
Building 3001	ITWBG3001	WW	11/11/93	0825
Lift Station 10	IWTLS10	WW	11/11/93	0935
Building 2127	IWTBG2127	WW	11/11/93	1045
Building 2211	IWTBG2211	WW	11/11/93	1130
Old Lift Station 6	IWTLS6OLD	WW	11/11/93	1315
New Lift Station 6	IWTLS6NEW	WW	11/11/93	1330
Building 2280	IWTBG2280	WW	11/11/93	1500
Building 3221	IWTBG3221	WW	11/11/93	1545
NA	EB2	EB	11/10/93	1350

WW - Wastewater
FD - Field Duplicate
MS - Matrix Spike

MSD - Matrix Spike Duplicate
EB - Equipment Blank
NA - Not Applicable

lift station samples. Each of the field duplicate samples was collected along with the samples from Lift Station 2.

One matrix spike (MS) and one matrix spike duplicate (MSD) were collected during the first sampling event along with the collection of the Lift Station 2 sample.

3.3 SOIL GAS, SOIL, AND SEDIMENT SAMPLING

Subsurface investigations and sampling of surface soils and sediments were conducted to determine the location, nature, and extent of shallow contamination at the site. This was accomplished with a soil gas survey, drilling and sampling eighty-seven soil borings, and sampling surface soil at twenty locations and sediment at six locations along East Soldier Creek. Drilling activities complied with applicable State of Oklahoma regulations and all samples were collected as prescribed by the work plan. Specific soil and sediment sampling methodologies are described below.

3.3.1 Soil Gas Survey

Soil gas sampling locations were staked at all sites where soil borings were to be drilled. Sampling locations were also staked in areas where visual evidence of cracks indicated potential leaks from a SWMU. To provide coverage around each SWMU, the initial soil gas sampling points were located approximately 25 feet apart. Underground electrical lines and wastewater treatment pipes were identified, and sampling locations were adjusted and approved under a Tinker AFB excavation permit before any subsurface activities were initiated. Once the initial phase of the soil gas survey was completed, additional points were added radially outward in areas where the concentration of at least one compound was greater than 1 part per million volume per volume (ppmv). These locations were also cleared for utilities by Tinker AFB before being sampled.

The soil gas samples were analyzed using an HNU® 321 GC with both a photoionization detector (PID) and a flame ionization detector (FID) for the following compounds: vinyl chloride, 1,1-dichloroethene, 1,2-dichloroethene, trichloroethane, 1,2-dichloroethane, benzene, TCE, toluene, PCE, ethylbenzene, and total xylenes. Details on soil gas analytical procedures and the configuration of the field GC are given in section 3.8.

Sampling equipment used in the survey included:

- Bosch® electric hammer for driving and augering,
- Stainless steel probe with sampling screen,
- Stainless steel screen covers,
- 3-foot hollow metal rods (extensions),
- 1/8-inch-inside-diameter Tygon® tubing,
- Vacuum pump,
- HNU PI-101 PID,
- Gas-tight syringes, and
- Hi-lift® jack.

The probe and extensions were driven to a depth of approximately 5 feet using the electric hammer. The total depth varied depending on subsurface conditions.

At some locations, a concrete core cutter was used to provide access to the subsurface. An 18-inch auger was used when the top soil was too difficult to hammer through or was covered in asphalt. When the probe could not be driven to depths greater than 2 feet, it was removed and a new location was attempted. Once the probe was inserted, the screen was exposed by retracting the probe 3 to 4 inches by hand or with the Hi-lift jack. The tubing, which was connected to the screen through the rod extensions, was attached to the vacuum pump. The pump exhaust was monitored for organic vapors with a PID. At least two tubing volumes of soil gas were purged before a sample was collected. At a flow rate of 10 standard cubic feet per hour (scfh) with 10 feet of 0.01-foot-diameter tubing and piping, 0.53 seconds was required to purge two volumes of the tubing and piping.

After purging the tubing and probe, a 10-milliliter (mL) syringe was inserted into the tubing and a sample was extracted. Two syringes were filled per sampling point and hand-delivered to the onsite laboratory for analysis. The probe and extensions were removed from the ground after sampling using a Hi-lift jack. The equipment was disassembled and decontaminated according to procedures described in section 3.5. New tubing was used for each sample.

Information recorded in the field logbooks for each sample included point driving conditions, depth, time of sampling, sampling conditions, field duplicates taken, PID readings, and presence of water and condensation. When soil adhered to the probe screen cover after the cover was removed from the ground, a description of the soil was included in the logbook. The stake for each sample location was marked with the sample identification number and hammered into the ground. After surveying the locations as described in section 3.6, any holes in concrete or asphalt were plugged.

3.3.2 Soil Boring Drilling

Eighty-seven exploratory soil borings were drilled at the Tinker AFB WWTF site from October 20, 1993, to November 20, 1993. The Winnek Company of Tulsa, Oklahoma (Winnek), performed drilling activities under the supervision of qualified ES geologists. A series of soil borings was drilled adjacent to each of the SWMUs located at the site. A total of 170 soil samples were collected from the borings. Soil samples were collected at each boring location for the following chemical analyses:

- Metals: arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and zinc, Methods 6010, 7471, and 7761;
- Method 8240 VOCs;
- Method 8270 SVOCs; and
- Method 9010 cyanide.

In addition, soil samples collected at the oil separator (SWMU 24.2) and the recirculation pit (RCP) were analyzed for:

- Method 8015 TPH (modified California method).

Soil samples were also analyzed for geotechnical parameters, including Atterberg limits, particle size, moisture content, organic content, permeability, and

bulk density. The results of the chemical analysis of soil boring samples were used to characterize the nature and extent of soil contamination at the site.

The boring locations were determined and marked with wooden stakes prior to initiating any soil boring activities, and inspected by base personnel. Underground utility maps were used to help select boring locations. Because of the large amount of underground and overground utilities at the site, each drilling location was approved in a digging permit by base personnel prior to drilling. Drilling activities were coordinated with Air Force operations and emergency personnel in case any unexpected problems were encountered.

Winnek usually operated two drilling rigs simultaneously to expedite completion of the project. Mobile B-53 and a Mobile B-61 drilling rig were used at the locations accessible by a truck-mounted rig. Both drilling rigs were equipped with 7-inch outside-diameter hollow-stem augers which were used to advance each boring to the specified depth (approximately 18 feet below ground surface [bgs]). Continuous-core soil samples were collected from the augered interval using the CME sampling system with 5-foot-long carbon-steel split-tube samplers. Due to the variable topography of the site, the water table was encountered as shallow as 4 feet bgs in some areas (e.g., SWMU 32.5 and SWMU 32.6), and not encountered at all in others. Where shallow water was encountered, borings were advanced approximately 3 feet below the water table.

In congested areas which were not accessible with a truck-mounted rig, a small skid-mounted Mobile B-24 rig was used. The Mobile B-24 rig advanced boreholes using 3.5-inch-outside-diameter solid-stem augers. Continuous-core soil samples were collected using a 1-inch-inside-diameter (1.5 to 2.0 feet long) stainless-steel split spoon. Split spoons were driven into the subsurface by dropping a 140-pound hammer approximately 30 inches. Split-spoon samples were collected until split-spoon refusal was reached. The depths to refusal varied.

A few drilling locations were inaccessible even with the small Mobile B-24. These locations were sampled using a gas-powered hand-auger ("little beaver") and a manual hand-auger to drill and collect soil samples. The "little beaver" was equipped with a small-diameter solid-stem auger which was used to advance the borehole to the top of the sampled interval. Soil samples were collected with a manual auger. The total depth of soil borings advanced by these methods varied.

After each soil boring was drilled and sampled, the borehole was geophysically logged using methods described in section 3.3.6. After geophysical logging was completed, each borehole was abandoned in accordance with State of Oklahoma regulations. Each borehole was plugged with neat cement grout containing 3 to 5 percent bentonite and weighing approximately 13.5 pounds per gallon. The grout slurry was pumped through a 1.25-inch-diameter tremie pipe to the bottom of the borehole until the grout filled the hole to ground surface. For grouting to a depth of 5 feet or less, the grout was poured from the surface. The grout level in the boreholes settled overnight to approximately 2 to 3 feet bgs. Each borehole was subsequently topped off with grout to ground surface. A wooden stake identifying the soil boring was placed next to the abandoned borehole location for surveying

purposes. All soil boring locations were surveyed following the procedures outlined in section 3.7.

During drilling, organic vapors were monitored in the breathing zone using a Foxboro® organic vapor analyzer (OVA), HNU PID, or a Porta-FID® II. Background organic vapor levels were established by scanning the upwind perimeter of the boring site prior to initiating drilling activities. In addition, an HMX®-271 combustible-gas indicator was used to monitor the percent lower explosive limit (%LEL) and hydrogen sulfide (H₂S) concentrations. Action levels followed those specified in the health and safety plan. Sensidyne® detection tubes for specific compounds (e.g., vinyl chloride) were used as necessary, and results were recorded in the field logbook. All equipment used to monitor organic vapors and combustible gases were calibrated according to the manufacturer's specifications on a daily basis. Calibration information was recorded in the field logbook.

It was necessary to upgrade to level B personal protective equipment around the inactive industrial sludge drying beds (SWMU 24.19) and at Tanks D-1 and D-2 (SWMU 24.2) due to high concentrations of vinyl chloride which surpassed or were expected to surpass 1 ppm in the breathing zone. An exclusion zone, contamination-reduction zone, and support zone were set up during drilling. All personnel working within the exclusion zone wore the appropriate personal protective equipment, including respirator and supplied air. Air tanks were set up in the support zone, and back-up personnel were available in case of an emergency.

3.3.3 Soil Boring Sampling

Continuous-core subsurface soil samples were collected from most soil borings using a 5-foot-long CME core split-tube sampler. Soil samples were collected for lithologic description, organic vapor scanning, headspace screening, visual inspection for evidence of contamination, geotechnical analysis, and chemical analysis. Geotechnical methods are discussed in section 3.3.4. This information was recorded in the field logbook and/or on the drilling log.

Lithologic descriptions of soil samples were recorded on drilling logs by a qualified ES geologist. Lithologic descriptions consisted of the predominant lithology, followed by qualifying adjectives describing color, grain size, sorting (grading), grain shape, plasticity (if clay), hardness, textural features, bedding, and moisture content. Soils were described using the Unified Soil Classification System (ASTM D2488-84), and colors were described using a Munsell soil color chart. The drilling logs are contained in appendix A.

Soil core samples collected during drilling were scanned with an OVA, HNU, or FID to detect the presence of VOCs. Samples were also checked for discoloration and odor. The results were recorded on the drilling logs. Soil samples were chosen for chemical analysis based on visual observations and the presence of VOCs during scanning. Two or three soil samples were chosen for chemical analysis from each soil boring location. If VOCs were not detected during scanning, two samples were collected for chemical analysis, one just above the water table and one selected randomly between the surface and the water table.

Samples to be analyzed for VOCs were collected first and immediately placed into sample jars to minimize volatilization of any contaminants present. All other soil samples were composited in a stainless steel bowl and thoroughly mixed to produce a homogeneous sample before being placed into sample jars. All sample jars were properly labeled, tightly sealed, and immediately placed on ice in sample coolers. At the end of each day, soil sample jars were packed in ice in coolers for overnight shipment to the laboratory. Chain-of-custody forms and IRPIMS data (on a computer disk) were completed as specified in the work plan and included with each shipment of soil samples to the laboratory. Table 3.3 summarizes the information collected from the soil borings.

To prevent cross-contamination, all sampling equipment (e.g., CME sampler, split spoons, and hand augers) which had direct contact with samples was decontaminated prior to each sampling event. Nonsampling equipment items were decontaminated between soil boring locations. Decontamination procedures are described in section 3.5.

QA samples collected during soil boring sampling included trip blanks, field replicates, equipment rinsate blanks, ambient blanks, material blanks, and MS/MSDs. Equipment rinsate blanks were collected at five boring locations and analyzed for the same chemical constituents as the corresponding soil samples. The ambient blanks taken at the oil separator (SWMU 24.3) and the recirculation pit (RCP) were analyzed for VOCs. Material blanks of ASTM Type II water were collected to test water used to decontaminate sampling equipment and were analyzed for VOCs. A discussion and results of quality assurance/quality control (QA/QC) samples are presented in appendix J.

3.3.4 Geotechnical Sampling

Forty-one geotechnical samples were collected during soil boring drilling for physical analysis. Most of the geotechnical samples were collected by driving a 2-foot-long thin-walled Shelby tube into the undisturbed soil. The Shelby tube was driven by using downward hydraulic pressure on the head of the drilling rig. When the Shelby tube was extracted, the ends were waxed and capped for preservation. The amount of soil recovered in the Shelby tube was noted on the drilling logs.

An attempt was made to collect one Shelby tube sample from each soil boring at different depth intervals to get complete coverage of physical parameters at the site. However, because of unexpectedly hard subsurface conditions, Shelby tubes typically could not be advanced past a certain depth. Therefore, most Shelby tube samples were taken from the 0- to 12-foot interval. In an effort to obtain geotechnical samples from depths greater than 12 feet, grab samples were collected and sealed in Zip-Loc® bags. Geotechnical grab samples were analyzed for fewer physical parameters than the corresponding Shelby tube samples.

Geotechnical samples were properly labeled and hand-delivered to the Professional Service Industries, Inc. (PSI) laboratory in Oklahoma City, Oklahoma. Shelby tube samples were analyzed for the following physical parameters: bulk density, permeability, moisture content, Atterberg limits, organic content, and

Table 3.3
Soil Boring Summary Data
Tinker Air Force Base, Oklahoma

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)					Geophysical Log	Abandonment Date		
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Total Metals (SW6010)			Cyanide SW9010	TPH (SW8015 mod)
S32.1	SB1	10/27/93	5.0-5.5	0900	N1	SO	CC	18	X	X	X	X	X	Yes	10/28/93
	SB1	10/27/93	8.5-9.0	0920	N1	SO			X	X	X	X	X		
	SB1	10/27/93	14.5-15.5	1010	N1	SO			X	X	X	X	X		
	SB1	10/27/93	14.5-15.5	1010	FR1	SO			X	X	X	X	X		
	SB1	10/27/93	14.5-15.5	1010	MS1	SO			X	X	X	X	X		
	SB1	10/27/93	14.5-15.5	1010	SD1	SO			X	X	X	X	X		
	SB2	10/26/93	6.5-8.0	1537	N1	SO	CC	18	X	X	X	X	X	Yes	10/28/93
	SB2	10/26/93	16.0-18.0	1700	N1	SO			X	X	X	X	X		
	SB3	10/27/93	8.0-8.5	1240	N1	SO	CC	18	X	X	X	X	X	Yes	10/28/93
	SB3	10/27/93	17.5-18.0	1410	N1	SO			X	X	X	X	X		
S32.2	SB1	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SB2	10/27/93	5.0-7.0	0950	N1	SO	CC	18	X	X	X	X	X	Yes	10/29/93
	SB2	10/27/93	5.0-7.0	0950	FR1	SO			X	X	X	X	X		
	SB2	10/27/93	12.5-15.0	1100	N1	SO			X	X	X	X	X		
	SB2	10/27/93	12.5-15.0	1100	MS1	SO			X	X	X	X	X		
	SB2	10/27/93	12.5-15.0	1100	SD1	SO			X	X	X	X	X		
	SB3	10/27/93	6.0-8.0	1310	N1	SO	CC	18	X	X	X	X	X	Yes	10/28/93
	SB3	10/27/93	16.0-18.0	1400	N1	SO			X	X	X	X	X		
	SB1	11/5/93	4.0-6.0	1055	N1	SO	SS	10	X	X	X	X	X	Yes	11/7/93
	SB1	11/5/93	4.0-6.0	1055	FR1	SO			X	X	X	X	X		
S32.3	SB1	11/5/93	9.5-10.0	1330	N1	SO			X	X	X	X	X		
	SB2	10/21/93	4.0-6.0	1122	N1	SO	SS	18	X	X	X	X	X	Yes	10/25/93
	SB2	10/22/93	12.0-12.7	1025	N1	SO			X	X	X	X	X		
	SB3	10/27/93	NA	NA	NA	NA	NA	3.5	NA	NA	NA	NA	NA	No	10/28/93
	SB4	10/27/93	6.0-6.5	1615	N1	SO	CC	18	X	X	X	X	X	Yes	10/28/93
	SB4	10/27/93	17.0-17.5	1715	N1	SO			X	X	X	X	X		
	SB1	11/1/93	7.0-7.5	1400	N1	SO	SS	11.5	X	X	X	X	X	Yes	11/7/93
	SB2	10/21/93	0.0-2.0	0940	N1	SO	CC	18	X	X	X	X	X	Yes	10/21/93
	SB2	10/21/93	7.5-9.0	1045	N1	SO			X	X	X	X	X		
	SB3	10/20/93	6.0-8.0	1205	N1	SO	CC	18	X	X	X	X	X	Yes	10/21/93
S32.4	SB3	10/20/93	14.0-16.0	1410	N1	SO			X	X	X	X	X		
	SB4	10/21/93	10.0-12.0	1507	N1	SO	CC	18	X	X	X	X	X	Yes	10/21/93
	SB4	10/21/93	15.0-16.0	1600	N1	SO			X	X	X	X	X		
	SB5	10/22/93	5.0-7.0	0900	N1	SO	CC	18	X	X	X	X	X	Yes	10/25/93
	SB5	10/22/93	13.0-15.0	1020	N1	SO			X	X	X	X	X		
	SB5	10/22/93	15.0-16.0	1055	N1	SO			X	X	X	X	X		
	SB6	11/5/93	4.0-5.5	1600	N1	SO	SS	8.5	X	X	X	X	X	Yes	11/7/93
	SB6	11/5/93	8.0-8.5	1640	N1	SO			X	X	X	X	X		
									X	X	X	X	X		
									X	X	X	X	X		

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Table 3.3, continued

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)					Geophysical Log	Abandonment Date		
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Total Metals (SW6010)			Cyanide SW9010	TPH (SW8015 mod)
S32.5	SB1	11/16/93	2.0-3.0	1515	N1	SO	HA	X	X	X	X	Yes	11/17/93		
	SB1	11/16/93	5.0-6.0	1540	N1	SO		X	X	X	X				
	SB2	11/16/93	3.5-4.0	1000	N1	SO	HA	X	X	X	X	Yes	11/17/93		
	SB2	11/16/93	5.5-6.0	1130	N1	SO		X	X	X	X				
	SB3	11/10/93	2.0-4.0	0814	N1	SO	SS	X	X	X	X	Yes	11/11/93		
	SB3	11/10/93	2.0-4.0	0814	FR1	SO		X	X	X	X				
	SB3	11/10/93	6.0-7.5	0847	N1	SO		X	X	X	X				
S32.6	SB1	11/16/93	2.0-3.0	0920	N1	SO	HA	X	X	X	X	Yes	11/17/93		
S32.8	SB1	10/28/93	5.5-7.5	1540	N1	SO	CC	X	X	X	X	Yes	10/29/93		
	SB1	10/28/93	14.5-16.5	1630	N1	SO		X	X	X	X				
	SB2	10/29/93	0.0-2.0	0810	N1	SO	CC	X	X	X	X	Yes	11/7/93		
	SB2	10/29/93	9.0-12.0	0850	N1	SO		X	X	X	X				
	SB2	10/29/93	12.0-15.0	0915	N1	SO		X	X	X	X				
	SB3	10/29/93	6.0-8.0	1100	N1	SO	CC	X	X	X	X	Yes	11/7/93		
	SB3	10/29/93	12.5-14.0	1123	N1	SO		X	X	X	X				
	SB3	10/29/93	NA	1145	EB1	WQ	SS/G	X	X	X	X	NA	NA		
	SB4	11/4/93	8.0-9.0	1130	N1	SO	CC	X	X	X	X	Yes	11/7/93		
	SB5	11/4/93	12.0-13.5	1225	N1	SO		X	X	X	X				
	SB5	11/4/93	6.0-7.0	1425	N1	SO	CC	X	X	X	X	Yes	11/7/93		
	SB5	11/4/93	11.5-13.5	1500	N1	SO		X	X	X	X				
	SB5	11/4/93	11.5-13.5	1500	MS1	SO		X	X	X	X				
	SB5	11/4/93	11.5-13.5	1500	SD1	SO		X	X	X	X				
	SB6	11/5/93	11.5-13.0	0850	N1	SO	CC	X	X	X	X	Yes	11/7/93		
	SB6	11/5/93	17.0-18.0	0923	N1	SO		X	X	X	X				
	SB7	11/6/93	8.0-9.0	0907	N1	SO	CC	X	X	X	X	Yes	11/7/93		
SB7	11/6/93	13.0-14.0	1003	N1	SO		X	X	X	X					
SB7	11/6/93	13.0-14.0	1003	FR1	SO		X	X	X	X					
SB8	11/6/93	2.5-3.5	1121	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB8	11/6/93	14.0-15.0	1205	N1	SO		X	X	X	X					
SB9	11/3/93	14.5-15.5	1600	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB9	11/3/93	16.5-18.0	1615	N1	SO		X	X	X	X					
SB10	11/3/93	11.0-12.0	1215	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB10	11/3/93	14.5-16.0	1310	N1	SO		X	X	X	X					
SB10	11/3/93	14.5-16.0	1310	FR1	SO		X	X	X	X					
SB11	11/3/93	15.0-16.5	0940	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB11	11/3/93	16.5-17.5	1000	N1	SO		X	X	X	X					
SB12	11/2/93	10.0-11.5	1540	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB12	11/2/93	17.0-18.0	1615	N1	SO		X	X	X	X					
SB13	11/2/93	13.0-14.5	1230	N1	SO	CC	X	X	X	X	Yes	11/7/93			
SB13	11/2/93	16.0-18.0	1250	N1	SO		X	X	X	X					
SB13	11/2/93	16.0-18.0	1250	MS1	SO		X	X	X	X	Yes	11/7/93			

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Table 3.3, continued

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)					Geophysical Log	Abandonment Date		
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Total Metals (SW6010)			Cyanide SW9010	TPH (SW8015 mod)
S32.8	SB13	11/2/93	16.0-18.0	1250	SD1	SO		CC	X	X	X	X	Yes	11/7/93	
	SB14	11/2/93	9.5-11.5	0940	N1	SO			X	X	X				
	SB14	11/2/93	9.5-11.5	0940	FR1	SO			X	X	X				
	SB14	11/2/93	16.5-18.0	1020	N1	SO			X	X	X				
	SB15	11/1/93	9.5-11.0	1515	N1	SO		CC	X	X	X	X	Yes	11/7/93	
	SB15	11/1/93	15.5-17.0	1600	N1	SO			X	X	X	X			
	SB15	11/1/93	17.0-18.0	1630	N1	SO			X	X	X	X			
	SB16	11/5/93	4.5-6.5	1420	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB16	11/5/93	4.5-6.5	1420	FR1	SO			X	X	X	X			
	SB16	11/5/93	12.5-14.5	1530	N1	SO			X	X	X	X			
	SB16	11/5/93	12.5-14.5	1530	MS1	SO			X	X	X	X			
	SB16	11/5/93	12.5-14.5	1530	SD1	SO			X	X	X	X			
	SB16	11/5/93	15.5-17.0	1610	N1	SO			X	X	X	X			
	SB16	11/5/93	NA	1630	EB1	WQ		SS/G	X	X	X	X	NA	NA	
	SB17	11/1/93	9.0-11.0	0847	N1	SO		CC	X	X	X	X	Yes	11/7/93	
	SB17	11/1/93	14.0-16.0	0903	N1	SO			X	X	X	X			
	SB17	11/1/93	16.0-18.0	0925	N1	SO			X	X	X	X			
	SB18	11/4/93	9.5-11.5	0830	N1	SO		CC	X	X	X	X	Yes	11/7/93	
SB18	11/4/93	16.0-18.0	1000	N1	SO			X	X	X	X				
I24.1	SB1	11/8/93	5.5-6.0	1520	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB1	11/8/93	16.0-16.5	1620	N1	SO			X	X	X				
I24.2	SB1	ND	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	
	SB2	11/12/93	8.0-8.5	0900	N1	SO		CC	X	X	X	X	Yes	11/17/93	
	SB2	11/12/93	17.0-18.0	1000	N1	SO			X	X	X	X			
	SB3	11/4/93	6.0-7.0	1445	N1	SO		CC	X	X	X	X	Yes	11/7/93	
	SB3	11/4/93	16.5-17.5	1610	N1	SO			X	X	X	X			
	SB4	11/5/93	8.5-9.5	1140	N1	SO		CC	X	X	X	X	Yes	11/7/93	
	SB5	11/9/93	5.0-6.0	1105	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB5	11/9/93	13.0-13.5	1205	N1	SO			X	X	X	X			
	SB6	11/9/93	5.5-6.5	1510	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB6	11/9/93	17.0-18.0	1605	N1	SO			X	X	X	X			
	SB7	11/10/93	5.5-7.0	0900	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB7	11/10/93	5.5-7.0	0900	FR1	SO			X	X	X	X	Yes	11/11/93	
	SB7	11/10/93	13.5-14.5	1010	N1	SO			X	X	X	X			
	SB7	11/10/93	13.5-14.5	1010	MS1	SO			X	X	X	X			
	SB7	11/10/93	13.5-14.5	1010	SD1	SO			X	X	X	X			
	SB8	11/10/93	5.0-6.0	1230	N1	SO		CC	X	X	X	X	Yes	11/11/93	
	SB8	11/10/93	5.0-6.0	1230	FR1	SO			X	X	X	X			
	SB8	11/10/93	15.5-16.0	1335	N1	SO			X	X	X	X			
I24.3	SB1	11/8/93	5.5-6.5	0920	N1	SO		CC	X	X	X	X	Yes	11/11/93	

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Table 3.3, continued

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)						Geophysical Log	Abandonment Date		
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Total Metals (SW6010)	Cyanide SW9010			TPH (SW8015 mod)	
I24.3	SB1	11/8/93	13.0-14.0	1005	N1	SO					X	X	X	X		
	SB2	ND	NA	NA	NA	NA					NA	NA	NA	NA	NA	NA
	SB3	ND	NA	NA	NA	NA					NA	NA	NA	NA	NA	NA
	SB4	11/8/93	6.0-7.0	1155	N1	SO					X	X	X	X	Yes	11/11/93
	SB4	11/8/93	11.0-11.5	1345	N1	SO					X	X	X	X		NA
	SB4	11/8/93	NA	1200	AB1	WQ					X					
I24.4	SB1	10/28/93	4.5-5.0	0830	N1	SO					X	X	X	X		10/28/93
	SB1	10/28/93	10.0-11.0	0930	N1	SO					X	X	X			
I24.5	SB1	ND	NA	NA	NA	NA					NA				NA	NA
	SB2	10/28/93	3.0-3.5	1115	N1	SO					X	X	X	X	Yes	10/28/93
	SB2	10/28/93	15.0-16.0	1503	N1	SO					X	X	X	X		
	SB2	10/28/93	15.0-16.0	1503	FR1	SO					X	X	X	X		
	SB3	10/28/93	3.5-5.0	0910	N1	SO					X	X	X	X	No	10/29/93
I24.6	SB1	10/28/93	7.0-8.5	1035	N1	SO					X	X	X	X		10/29/93
	SB1	10/28/93	14.0-16.0	1125	N1	SO					X	X	X	X		
	SB1	10/28/93	14.0-16.0	1125	FR1	SO					X	X	X	X		
I24.7	SB1	11/8/93	4.0-6.0	1300	N1	SO					X	X	X	X		11/11/93
	SB1	11/8/93	8.0-10.0	1330	N1	SO					X	X	X	X		
	SB2	11/8/93	11.0-13.0	0921	N1	SO					X	X	X	X	Yes	11/11/93
I24.8	SB1	10/22/93	5.0-7.0	1510	N1	SO					X	X	X	X		10/25/93
	SB1	10/22/93	14.0-16.0	1550	N1	SO					X	X	X	X		
	SB1	10/22/93	14.0-16.0	1550	FR1	SO					X	X	X	X		
	SB2	11/4/93	10.0-11.0	1125	N1	SO					X	X	X	X	Yes	11/6/93
	SB2	11/4/93	17.0-17.5	1145	N1	SO					X	X	X	X		
	SB3	11/2/93	6.0-7.0	0930	N1	SO					X	X	X	X	Yes	11/6/93
	SB3	11/2/93	17.0-18.0	1130	N1	SO					X	X	X	X		
	SB4	11/9/93	4.0-5.5	1645	N1	SO					X	X	X	X	Yes	11/11/93
	SB4	11/9/93	8.0-9.5	1710	N1	SO					X	X	X	X		
I24.9	SB1	11/4/93	10.5-11.5	0825	N1	SO					X	X	X	X		11/6/93
	SB1	11/4/93	16.5-17.5	0925	N1	SO					X	X	X	X		
	SB2	11/10/93	2.0-4.0	0957	N1	SO					X	X	X	X	Yes	11/11/93
	SB2	11/10/93	2.0-4.0	0957	MS1	SO					X	X	X	X		
	SB2	11/10/93	2.0-4.0	0957	SD1	SO					X	X	X	X		
I24.10	SB1	10/25/93	4.0-6.0	1340	N1	SO					X	X	X	X		10/25/93
	SB1	10/25/93	13.0-15.0	1500	N1	SO					X	X	X	X	Yes	
	SB2	10/25/93	9.0-10.5	1330	N1	SO					X	X	X	X	Yes	10/25/93

Table 3.3, continued

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)						Geophysical Log	Abandonment Date			
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Metals (SW6010)	Cyanide SW9010			TPH (SW8015 mod)		
I24.10	SB2	10/25/93	16.0-18.0	1532	N1	SO		CC		X	X	X	X		Yes	11/7/93	
	SB3	11/3/93	6.0-7.0	1610	N1	SO				X	X	X	X				
	SB3	11/3/93	15.0-16.0	1700	N1	SO				X	X	X	X				
	SB4	11/2/93	9.0-10.0	1520	N1	SO		CC		X	X	X	X		Yes	11/6/93	
	SB4	11/2/93	13.5-14.0	1620	N1	SO				X	X	X	X				
	SB5	11/1/93	6.0-7.0	0845	N1	SO		CC		X	X	X	X		Yes	11/6/93	
I24.11	SB5	11/1/93	13.0-14.0	1730	N1	SO				X	X	X	X				
	SB1	11/17/93	4.0-5.0	0815	N1	SO		HA		X	X	X	X		Yes	11/17/93	
	SB1	11/17/93	4.0-5.0	0815	FR1	SO				X	X	X	X				
	SB1	11/17/93	4.0-5.0	0815	MS1	SO				X	X	X	X				
	SB1	11/17/93	4.0-5.0	0815	SD1	SO				X	X	X	X				
	SB1	11/17/93	8.0-9.0	0900	N1	SO				X	X	X	X				
	SB2	11/3/93	6.0-7.0	0840	N1	SO		CC		X	X	X	X		Yes	11/6/93	
	SB2	11/3/93	13.0-14.0	1015	N1	SO				X	X	X	X				
	SB3	11/8/93	4.0-6.0	1536	N1	SO		SS		X	X	X	X		Yes	11/11/93	
	SB3	11/8/93	8.0-9.0	1625	N1	SO				X	X	X	X				
	SB4	11/16/93	3.0-4.0	1410	N1	SO		HA		X	X	X	X		Yes	11/17/93	
	SB4	11/16/93	3.0-4.0	1410	FR1	SO				X	X	X	X				
	SB4	11/16/93	8.0-9.0	1440	N1	SO				X	X	X	X				
	I24.12	SB1	10/22/93	9.0-14.0	1400	N1	SO		CC		X	X	X	X		Yes	10/25/93
		SB1	10/22/93	14.0-18.0	1640	N1	SO				X	X	X	X			
SB2		10/25/93	8.0-9.5	1025	N1	SO		CC		X	X	X	X		Yes	10/25/93	
SB2		10/25/93	14.5-16.0	1100	N1	SO				X	X	X	X				
SB3		10/25/93	4.0-6.0	1000	N1	SO		CC		X	X	X	X		Yes	10/25/93	
SB3		10/25/93	14.0-16.0	1116	N1	SO				X	X	X	X				
SB4		10/26/93	6.5-8.0	0935	N1	SO		CC		X	X	X	X		Yes	10/28/93	
SB4		10/26/93	6.5-8.0	0935	FR1	SO				X	X	X	X				
SB4		10/26/93	12.5-14.0	1004	N1	SO				X	X	X	X				
SB5		11/9/93	6.0-7.5	1053	N1	SO		SS		X	X	X	X		Yes	11/11/93	
SB6		11/3/93	8.0-8.5	1305	N1	SO		CC		X	X	X	X		Yes	11/6/93	
SB6		11/3/93	15.0-16.0	1400	N1	SO				X	X	X	X				
I24.19		SB1	11/11/93	5.0-6.0	0800	N1	SO		CC		X	X	X	X		Yes	11/12/93
		SB1	11/11/93	5.0-6.0	0800	FR1	SO				X	X	X	X			
		SB1	11/11/93	16.0-17.0	0810	N1	SO				X	X	X	X			
	SB2	11/7/93	7.5-8.0	1010	N1	SO		CC		X	X	X	X		Yes	11/7/93	
	SB2	11/7/93	17.0-17.5	1050	N1	SO				X	X	X	X				
	SB3	11/6/93	5.5-6.5	0900	N1	SO		CC		X	X	X	X		Yes	11/7/93	
	SB3	11/6/93	17.5-18.0	0945	N1	SO				X	X	X	X				
	SB4	11/6/93	8.5-9.0	1140	N1	SO		CC		X	X	X	X		Yes	11/7/93	
	SB4	11/6/93	16.0-17.0	1205	N1	SO				X	X	X	X				
										X	X	X	X				

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Table 3.3. continued

SWMU No.	Soil Boring No.	Date Drilled	Interval (feet bgs)	Sample Information		Total Depth (feet bgs)	Chemical Analyses (analytical methods)					Geophysical Log	Abandonment Date	
				Time	Type		Matrix	Method	VOA (SW8240)	SVOA (SW8270)	Total			
											Metals (SW6010)			Cyanide SW9010
I24.19	SB5	11/7/93	7.5-8.0	0820	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB5	11/7/93	15.5-16.0	0845	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB6	11/6/93	6.5-7.0	1445	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB6	11/6/93	15.5-16.0	1515	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB7	11/7/93	6.5-7.5	1210	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB7	11/7/93	17.0-18.0	1245	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB8	11/7/93	6.0-7.0	1425	N1	SO	CC	18	X	X	X	X	Yes	11/7/93
	SB8	11/7/93	17.0-17.5	1450	N1	SO	SS/G	NA	X	X	X	X	NA	NA
	SB8	11/7/93	NA	1500	EB1	WQ	CC	18	X	X	X	X	Yes	11/12/93
	SB9	11/11/93	7.5-8.0	1315	N1	SO	SS/G	NA	X	X	X	X	NA	NA
	SB9	11/11/93	17.0-18.0	1340	N1	SO	CC	18	X	X	X	X	Yes	11/12/93
	SB9	11/11/93	NA	1430	EB1	WQ	SS/G	NA	X	X	X	X	NA	NA
RCP1	SB10	11/11/93	5.0-6.0	1020	N1	SO	CC	18	X	X	X	X	Yes	11/12/93
	SB10	11/11/93	17.0-18.0	1100	N1	SO	CC	18	X	X	X	X	Yes	11/12/93
	SB1	11/12/93	6.0-8.0	0855	N1	SO	SS	8	X	X	X	X	Yes	NA
	SB2	11/10/93	4.0-6.0	1206	N1	SO	SS	10	X	X	X	X	Yes	11/11/93
	SB2	11/10/93	6.0-8.0	1236	N1	SO	SS	10	X	X	X	X	Yes	11/11/93
	SB2	11/10/93	NA	1315	AB1	WQ	G	NA	X	X	X	X	NA	NA
	SB2	11/10/93	NA	1327	EB1	WQ	SS/G	NA	X	X	X	X	NA	NA
	SB3	11/10/93	0-1.5	1503	N1	SO	SS	7	X	X	X	X	Yes	11/11/93
	SB3	11/10/93	4.0-6.0	1536	N1	SO	SS	7	X	X	X	X	Yes	11/11/93
	NA	11/17/93	NA	1120	MB1	WQ	G	NA	X	X	X	X	NA	NA
	NA	11/17/93	NA	1200	MB2	WQ	G	NA	X	X	X	X	NA	NA

SWMU = solid waste management unit
 bgs = below ground surface
 VOA = volatile organic analysis
 SVOA = semi-volatile organic analysis
 TPH = total petroleum hydrocarbons
 ND = not drilled
 NA = not applicable or not analyzed

Sample Type Qualifiers:
 N1 = normal
 FR1 = field replicate
 MS1 = matrix spike
 SD1 = matrix spike duplicate
 EB1 = equipment blank
 AB1 = ambient blank
 MB1 = material blank

Sample Matrix Qualifiers:
 SO = soil
 WQ = water quality

Sample Method Qualifiers:
 CC = 5-foot continuous core sampler
 SS = split spoon
 HA = hand auger
 G = grab

particle size by hydrometer. Geotechnical grab samples were analyzed for the same physical parameters, excluding bulk density and permeability.

The results of the geotechnical analyses are presented in section 4. Table 3.4 lists the soil boring name and location, date sampled, sample interval, sample method, and physical analyses performed. Geotechnical laboratory analytical data are presented in appendix B.

3.3.5 Surface Soil and Sediment Sampling

Surface soil samples were collected at SWMUs 24.2, 24.3, 24.5, 24.19, 32.2, 32.3, 32.8, and the recirculation pit. Sample locations were determined by evidence of surface staining, stressed vegetation, and the requirements of the DCQAP. Samples were taken at a depth of 2 to 6 inches and obtained with a stainless-steel hand trowel. The samples were analyzed for:

- Metals: arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and zinc, Methods 6010, 7471, and 7761;
- Method 8240 VOCs;
- Method 8270 SVOCs;
- Method 8015 TPH (modified California method);
- Method 8080 PCBs; and
- Method 9010 Cyanide.

Samples collected for VOC analysis were collected first and placed immediately into a sample jar to minimize volatilization of any contaminants present. The jars were then tightly sealed, labeled, and placed on ice in coolers. Samples collected for SVOCs, total metals, total cyanides, and TPH analyses were mixed until homogeneous prior to placement in a jar. A soil sampling form was completed for each sample.

Seven sediment samples were collected from East Soldier Creek in two events 30 days apart. The samples were analyzed for the same compounds as the surface soil samples. Before sampling, sample containers were appropriately labeled. Sediment samples were collected with a stainless-steel trowel or bottom sampling dredge. Samples to be analyzed for VOCs were collected first, placed directly in the container with minimum disturbance, and sealed quickly. The sample location and description were noted on the sediment sampling form.

To prevent cross-contamination of samples, all soil and sediment sampling equipment which had direct contact with samples was decontaminated before each use. Decontamination procedures are described in section 3.5.

The sample locations for surface soil and sediment were staked for surveying. During the first sampling event, monuments were erected on both sides of the creek bed at each location to ensure that the second sampling event occurred at the same location.

Table 3.4
Geotechnical Summary Data
Tinker AFB, Oklahoma

SWMU No.	Soil Boring No.	Date Sampled	Sample Interval (feet bgs)	Sample Method	Bulk Density	Constant Head Permeability	Moisture Content	Atterberg Limits	Organic Content	Particle Size Hydrometer
32.1	SB2	10/26/93	10-12	T	X	X	X	X	X	X
	SB3	10/27/93	4-6	T	X	X	X	X	X	X
32.2	SB3	10/27/93	4-6	T	X	X	X	X	X	X
32.3	SB2	10/27/93	0-2	T	X	X	X	X	X	X
32.4	SB2	10/21/93	4-6	T	X	X	X	X	X	X
	SB4	10/21/93	6-8	T	X	X	X	X	X	X
	SB5	10/22/93	3-5	T	X	X	X	X	X	X
32.8	SB1	10/28/93	0.5-2.5	T	X	X	X	X	X	X
	SB2	10/29/93	2-4	T	X	X	X	X	X	X
	SB3	10/29/93	4-6	T	X	X	X	X	X	X
	SB4	11/4/93	4-6	T	X	X	X	X	X	X
	SB5	11/4/93	1-3	T	X	X	X	X	X	X
	SB6	11/5/93	6-8	T	X	X	X	X	X	X
	SB7	11/6/93	17-18	CC			X	X	X	X
	SB8	11/6/93	13-14	CC			X	X	X	X
	SB9	11/3/93	4-6	T	X	X	X	X	X	X
	SB10	11/3/93	1.5-3.5	T	X	X	X	X	X	X
	SB11	11/3/93	0.5-2.5	T	X	X	X	X	X	X
	SB12	11/2/93	0-2	T	X	X	X	X	X	X
	SB13	11/2/93	2-4	T	X	X	X	X	X	X
	SB15	11/1/93	2.5-4	T	X	X	X	X	X	X
	SB16	11/1/93	0-2	T	X	X	X	X	X	X
	SB17	11/1/93	6-8	T	X	X	X	X	X	X
	SB18	11/4/93	0.5-2.5	T	X	X	X	X	X	X
24.2	SB4	11/5/93	4-6	T	X	X	X	X	X	X
24.4	SB1	10/28/93	8-10	T	X	X	X	X	X	X
24.5	SB2	10/28/93	4-6	T	X	X	X	X	X	X

Table 3-4, cont.

SWMU No.	Soil Boring No.	Date Sampled	Sample Interval (feet bgs)	Sample Method	Bulk Density	Constant Head Permeability	Moisture Content	Atterberg Limits	Organic Content	Particle Size Hydrometer
24.8	SB1	10/22/93	0-2	T	X	X	X	X	X	X
	SB2	11/4/93	4-6	T	X	X	X	X	X	X
	SB3	11/2/93	4-5.5	T	X	X	X	X	X	X
24.10	SB1	10/25/93	2-4	T	X	X	X	X	X	X
	SB2	10/25/93	4-6	T	X	X	X	X	X	X
	SB3	11/3/93	9-11	T	X	X	X	X	X	X
	SB4	11/2/93	4-5	T	X	X	X	X	X	X
24.12	SB1	10/22/93	2-4	T	X	X	X	X	X	X
	SB2	10/25/93	4-6	T	X	X	X	X	X	X
	SB3	10/25/93	6-7	T	X	X	X	X	X	X
	SB4	10/26/93	8-10	T	X	X	X	X	X	X
	SB6	11/3/93	4-6	T	X	X	X	X	X	X
24.19	SB4	11/6/93	17-18	CC			X	X	X	X
	SB8	11/7/93	9.5-11.5	T	X	X	X	X	X	X

SWMU = solid waste management unit
bgs = below ground surface

Sample Method Qualifiers:
T = Shelby tube
CC = 5-foot continuous core sampler

3.3.6 Geophysical Logging

Eighty-five soil borings were geophysically logged by Century Geophysical of Tulsa, Oklahoma (Century). Century was prepared to run natural gamma-ray, spontaneous potential, and resistivity logs for each borehole as specified in the work plan. However, only a natural gamma-ray log was used because of the lack of fluid in the borehole. Base personnel did not want to introduce water into the boreholes to obtain these additional geophysical logs. The geophysical tool and cable were steam-cleaned at the decontamination pad prior to use in each borehole.

The natural gamma-ray log records the amount of natural gamma radiation emitted by the formation. Gamma-emitting radioisotopes (potassium-40, uranium-238, and thorium-232) tend to concentrate in clays. Therefore, the main use of the natural gamma-ray log in sedimentary formations is to identify lithology and stratigraphic correlation. Natural gamma-ray logs are measured and calibrated in American Petroleum Institute (API) gamma-ray units.

Results of geophysical logging are discussed in section 4. Table 3.3 specifies which soil borings were geophysically logged. The natural gamma-ray logs for each soil boring are presented in appendix C.

3.3.7 Sample Identification

An identification code was developed for soil gas, soil, and sediment to allow tracking and identification of the large number of samples collected for chemical and physical analyses. The sample identification code consisted of two parts. The first part identified the location: sanitary wastewater treatment unit SWMUs are designated as S32.x, industrial wastewater treatment unit SWMUs are designated as I24.x, and the recirculation pit was designated as RCP. The second part of the code identified the type of sampling and the sample number for that SWMU. Numbering of individual samples began with the northern-most location of each SWMU and continued in a clockwise direction. Any additional points added after the initial sampling followed the same pattern. The following codes indicate the type of sampling:

SG	Soil Gas
SB	Soil Boring
SS	Surface Soil
SE	Sediment

For example, a sample identified as S32.4SG3 was collected at SWMU 32.4 and was the third soil gas sample taken. Soil boring sample codes included depths in parentheses at the end of the sample identification. For example, I24.12SB1 (6-8) was taken at SWMU 24.12 from soil boring 1 at a depth of 6 to 8 feet.

3.3.8 Sample Handling

Sample handling procedures, specified in the DCQAP (ES, 1993b), were followed to maintain sample integrity. Samples were collected and placed in the appropriate prelabeled container. Soil gas samples were hand delivered to the field laboratory. Soil samples collected for chemical analysis by the offsite laboratory

were maintained at the proper temperature of 4°C and packaged to avoid breakage. Soil boring samples collected for geotechnical analyses were collected in Shelby tubes which were sealed with wax and properly labeled.

As specified in the DCQAP, sample chain-of-custody was maintained. Samples were kept in a secured area when not in the immediate possession of the sampler. Chain-of-custody forms accompanied the samples to the offsite laboratory. Custody seals were placed on the coolers to prevent tampering during shipment. Samples collected for chemical analyses were shipped to the laboratory in sealed coolers via overnight delivery service.

3.4 AIR SAMPLING

The air sampling was performed in two phases at the site. Phase A for an initial assessment was conducted from September 22 through 27, 1993, and Phase B was conducted from September 29 through November 9, 1993. Sampling activities are summarized in Table 3.5. The following is a discussion of sample identification methods, sample types, and parameters measured.

3.4.1 Sample Identification

Each sample collected was given an identification number based on sampling location, sampling date, and parameter sampled. The source sample identification number was further classified as "probe" or "flux" sample. The sample identification number was generated based on the following format:

- Sampling location
 - A1 through A13 for ambient locations;
 - P-1 through P-10, 1-S through 15-S, and 3-SU through 7-SU for process locations (3-SU through 7-SU for mercaptan bag samples only); and
 - S1 through S23 for source locations.

Locations listed as Snn are source emission sampling locations and are analogous to SWMU designations in that they identify a particular process unit as a test site. There are some non-SWMU process units included in the list of source sampling locations. The nnS designations denote ambient-type sampling locations used for H₂S and mercaptan screening and are physically not the process units, but are sample locations around possible sources of sulfide emission.

- Sampling date
 - The sampling dates were encoded in year, month, day format. For instance, a sample taken on September 22, 1993, would have a sampling date code represented by "930922."
- Parameter sampled
 - F = Formaldehyde samples,
 - G = VOC bag sample analyzed by field GC,

Table 3.5
Summary of Air Samples
Tinker AFB, Oklahoma

	Ambient Air Samples	<u>Process Exposure</u>		Source
		P ¹	S ²	
Number of stations	13	10	15	23
Parameter:				
Formaldehyde	63	50		60
VOC bag sample				122
Metal/TSP			9	
Phenol	271	210		128
Mercaptan			14	
SVOC PUFF	269	206		
Hydrogen sulfide	128			
VOC SUMMA	271	206		138
SVOC XAD				133

¹ Located near major treatment units

² Located near potential hydrogen sulfide sources

- H = Metals/total suspended particles (TSP) samples,
 - L = Phenol samples,
 - M = Mercaptan bag samples,
 - P = SVOC polyurethane foam filter (PUF) samples,
 - SA = First H₂S sample on a given day,
 - SB = Second H₂S sample on a given day,
 - V = VOC SUMMA® canister samples, and
 - X = SVOC XAD® tube samples.
- Probe or flux classification for source samples

For example, the identification number for a phenol sample taken at source location S2-2 using a flux chamber on October 14, 1993, would be "S2-2 - 931014 - L-Flux."

Prior to transfer of samples from their initial locations to the field trailer, sample identification number labels were placed on the sample modules, impingers, tubes, and SUMMA canisters. These samples were recovered and then entered into the master log with each sample being given a unique log number (sequential from first sample). The log number, sample number, sampling crew initials, recovery crew initials, and comments, if any, were then entered on a label and placed on the sample container. Each of the recovered samples, before being packed in coolers or boxes, was recorded on the chain-of-custody form. The chain-of-custody form was checked against the master log to ensure shipment of all samples collected.

3.4.2 Air Sample Collection

3.4.2.1 Ambient Sampling Schedule and Locations

Ambient air samples were collected from thirteen locations. Ambient locations A1 through A11 were chosen to represent the fencelines or boundaries of the treatment plant in all directions. A12 and A13 were located on base property northwest of the IWTP to monitor on- and off-base migration.

The 24-hour sampling routine at these locations was started between 8:00 A.M. and 12:00 NOON on Mondays, Wednesdays, and Fridays. This schedule varied occasionally when sampling was required on different weekdays. Hydrogen sulfide sampling began during the latter half of Phase B and lasted for 2 hours per sample. Hydrogen sulfide samples were collected at locations A1, A2, A3, A7, A11, A12, and A13, twice per day on Mondays, Wednesdays, and Fridays at the request of the Air Force. All samples collected at the ambient locations were shipped to the offsite laboratory for analysis on the same day as collection. Sampling techniques used for specific analyses are discussed in section 3.5.3. Figure 3.1 represents a typical ambient sampling location apparatus.

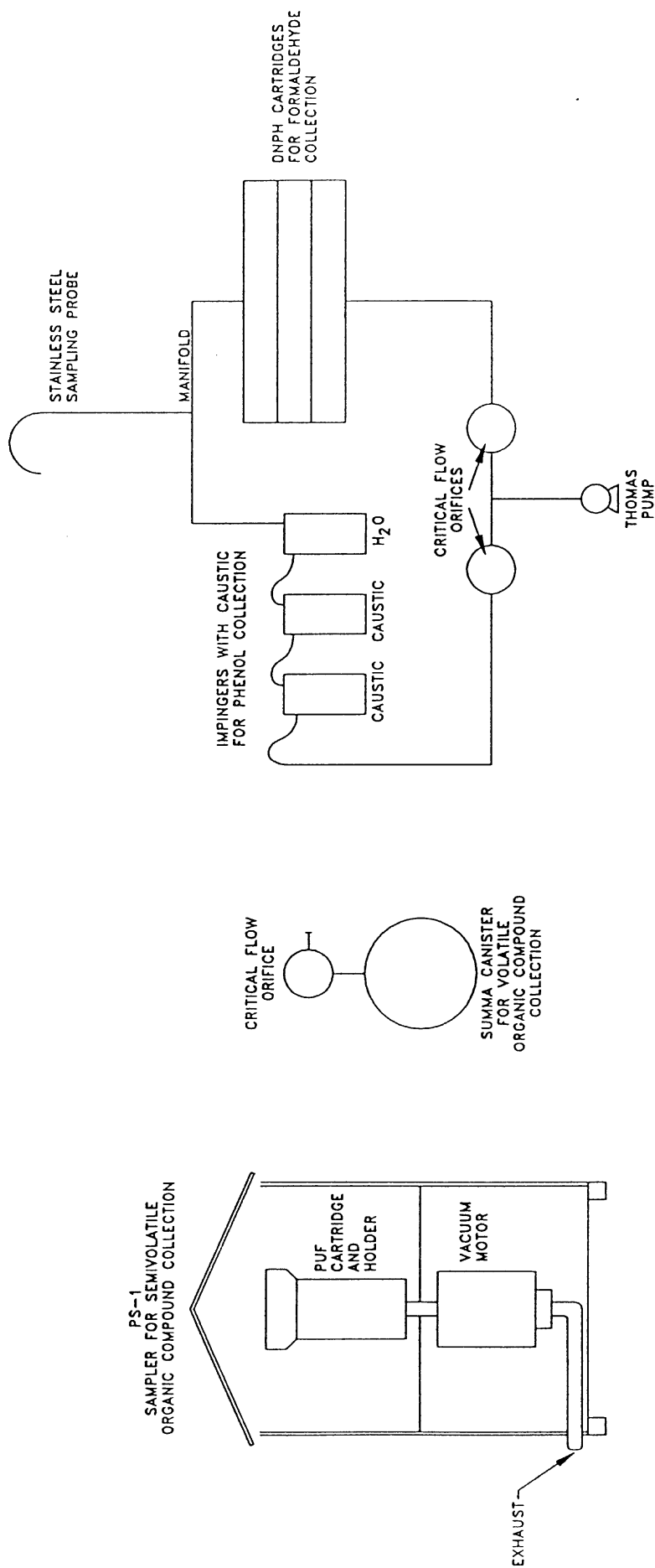


FIGURE 3.1
AMBIENT AIR SAMPLING SYSTEM
- FENCELINE STATIONS
- PROCESS STATIONS
TINKER AFB, OKLAHOMA

3.4.2.2 Process Exposure Sampling

Process exposure samples were collected from 25 locations identified as P-1 through P-10, and 1-S through 15-S. All of the "P" locations were chosen for their proximity to the major treatment units at the treatment plant. The "-S" locations were selected for their proximity to potential sources of hydrogen sulfide and as possible areas of higher hydrogen sulfide concentrations.

VOC, SVOC, phenol, and formaldehyde samples were collected only at the "P" locations on the same sampling schedule as the ambient locations. Metal/TSP samples were collected at P-2, P-3, and P-4 during the end of Phase A and at the beginning of Phase B. In addition, mercaptan samples were collected at locations 3-SU, 4-SU, 5-SU, 6-SU, and 7-SU. Furthermore, H₂S surveys were conducted with a portable monitoring instrument at all "-S" locations. Figure 3.1 represents a typical "P" location apparatus. All samples collected at the process locations were shipped to the offsite laboratory for analysis on the day they were collected, except during the first week of sampling, when one day lapsed before shipment.

3.4.2.3 Source Sampling

Air samples were collected from source locations at twenty-three sites identified as S1 through S23. These locations are the actual unit processes and unit operations at the wastewater treatment plant. As mentioned previously, the source sampling locations (S1 to S23) were locations on the surface of a tank or stack of a particular process unit. The tank or process unit corresponded to a SWMU (or non-SWMU). Probes and flux chambers were used to collect air samples from the source locations. At five locations (S2, S3, S5, S9, and S12), both flux chambers and probes were used during phase A. Source sampling of S12 was discontinued for phase B. The remaining stations were sampled using only probes. The probe and the flux chamber used for source sampling are discussed briefly in this section. The probe samples were taken to demonstrate whether this type of sampling could be used to indicate source strength in lieu of the more complex flux chamber sampling.

The probe was a steel tube with holes at regular intervals facing the wastewater surface. During sampling, the probe was suspended about 2 inches above and parallel to the water surface with one end capped and the other end connected to a Teflon line. The Teflon line was connected to a sampling manifold mounted on a fencepost at the rim of the source.

The flux chamber used for sampling the sources was an acrylic dome fitted to a steel collar. The dome had four openings serving as inlets or outlets. One opening was connected to a steel tube with holes at regular intervals to supply sweep gas along the inner circumference of the flux chamber. This opening was connected to a nitrogen supply line on the outside. A second opening was used to place a thermocouple in the flux chamber. A third opening was connected to a line attached to a sampling manifold mounted on the same fencepost as the probe manifold. The last opening was connected to a line with a rotameter attached to the other end. The rotameter was used to measure and regulate nitrogen flow. Polyethylene foam was used to float the flux chambers in the tanks/sources. Prior to sampling, all lines connected to the flux chamber were purged for at least

4 minutes by supplying nitrogen to the flux chamber. While sampling, the sweep gas rotameter was used as an indicator to constantly adjust the flow of nitrogen to the flux chamber. The nitrogen inflow was adjusted to maintain a constant liquid level in the flux chamber. This ensured a representative sample being collected.

Seventy-minute sampling runs for SVOCs, phenol, and formaldehyde at the source locations were started between 8:00 A.M. and 12:00 NOON on Mondays, Wednesdays, and Fridays. Sampling occasionally was required on additional days during the work week. VOC sampling runs were 30 minutes long at 125 cc/min, but followed the same sampling schedule as the other parameters.

Source samples were also collected in a Tedlar® bag for VOC analysis by GC. These "grab" samples required between 5 seconds and 5 minutes for the bag to fill. Grab samples were analyzed by a GC within minutes after collection. All other source samples were shipped to the offsite laboratory on the same day collected, except during the first week of sampling. Figure 3.2 represents a typical source sampling apparatus. Operation of the flux chambers followed the procedures *Measurement of Gasoline Emission Rates from Land Surface Using an Emission Isolation Flux Chamber* (US EPA, 1986).

3.4.3 Parameter Sampling

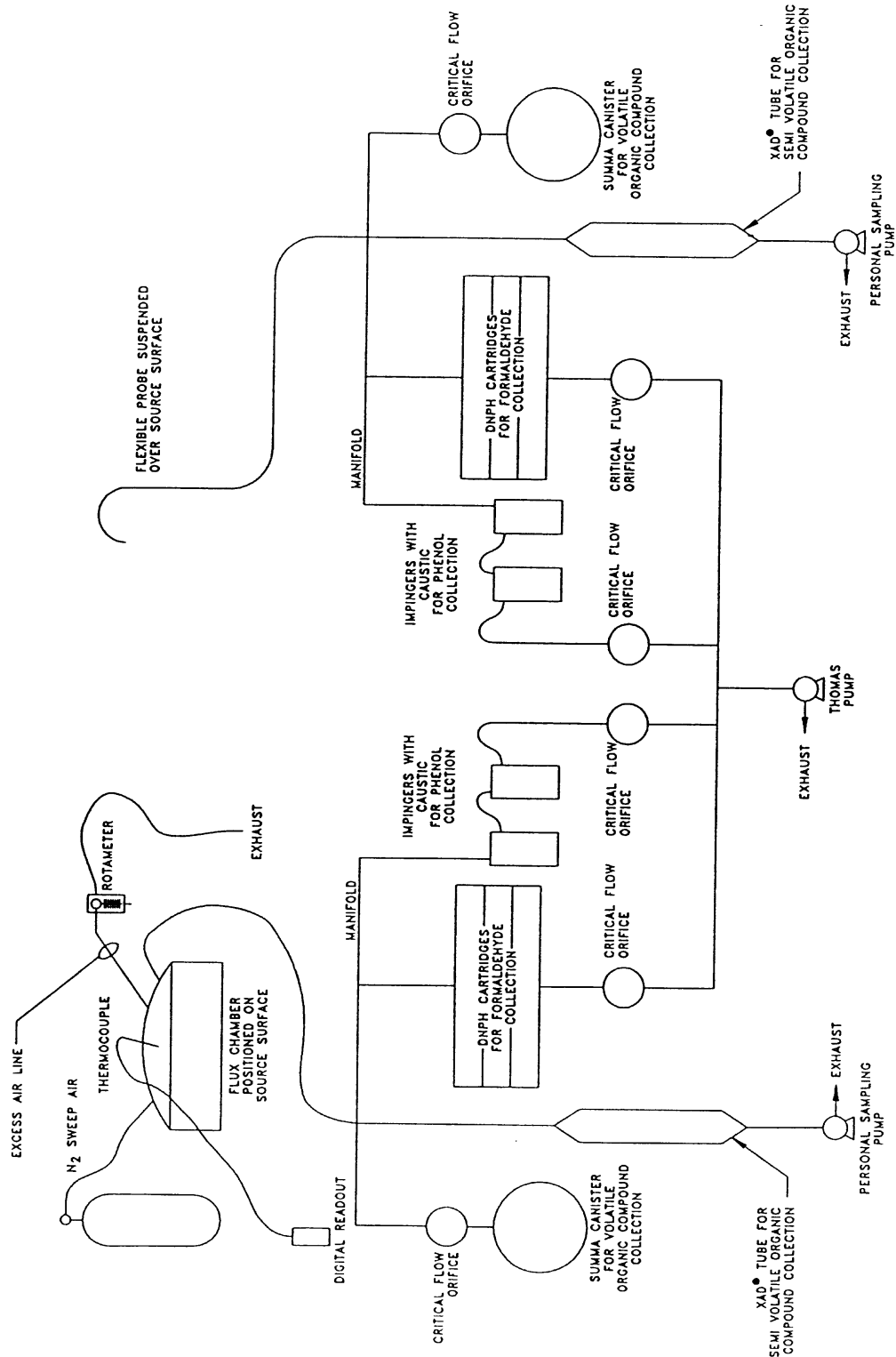
The following sections describe the methods used to collect samples to be analyzed for a variety of parameters. As much as possible, similar techniques and procedures were used for both the emission and the ambient sampling. Most of the source measurement techniques, however, involved modification of an ambient-type procedure for the sample extraction and, in some cases, for the analysis also. By example, VOCs were collected in SUMMA canisters for both source and ambient samples. For the ambient samples (A and P locations), the referenced EPA TO method was used. For the source sampling (Snn locations), we, of necessity, developed a procedure, described in the workplan SOP17, to get the sample from the surface of the tank to the canister (ES, 1993). Similar adaptations were made for other procedures, and these involved sample volume, sample time, method of extraction, and amount of sorbent media. In each instance, orifices were calibrated with an electronic bubble meter.

3.4.3.1 VOC Sampling

Ambient air VOC samples were collected with the guidance of the EPA Compendium Method TO-14 (EPA, 1988). Samples collected from ambient and process locations for VOC analysis were collected in 15-liter SUMMA canisters at 5.2 mL/minute (min) for 24 hours (nominal). Samples collected from sources for VOC analysis were collected in 6-liter SUMMA canisters at 125 mL/min for 30 minutes (nominal). The SUMMA canisters were placed on the ground away from the exhausts of the other sampling devices. A calibrated critical flow orifice was attached to the SUMMA canister before sampling was started to ensure the proper air flow rate.

FIGURE 3.2
SOURCE
SAMPLING SYSTEM

TINKER AFB, OKLAHOMA



To start sampling, the valve at the top of the SUMMA canister was opened and the start time was noted. For source samples, the SUMMA canister was connected to the flux chamber or probe sampling manifold before opening. To stop sampling, the valve was closed and the stop time was noted. If the SUMMA canister was connected to the flux chamber manifold, the flux chamber temperature was noted. The critical flow orifice was disconnected and the opening capped off before the SUMMA canister was shipped to the offsite laboratory for analysis.

3.4.3.2 SVOC Sampling

Ambient and process air samples collected for SVOC analysis were collected using guidance for EPA Compendium Method TO-4 (EPA, 1988). A typical PS-1 sampler with a sample module was used to collect samples for SVOC analysis. In the field trailer, the module was loaded with a prepacked glass cartridge and a quartz filter. The glass cartridge had a steel screen fitted at the lower end and was packed with XAD resin. The XAD resin was sandwiched between PUFs. A quartz filter preceding the foam and XAD resin was placed on a metal screen in the module for particle collection. The loaded module was taken to the ambient location and connected to the vacuum motor in the PS-1 sampler.

To start sampling, the vacuum motor was started, and the start time, temperature, barometric pressure, magnehelic reading, and elapsed-time reading were noted. The vacuum motor pulled ambient air through the sampling cartridge. To stop sampling, the vacuum motor was stopped and the stop time, temperature, barometric pressure, magnehelic reading, and elapsed timer reading were noted. The sample module was then disconnected from the vacuum motor and taken to the trailer for recovery. During recovery, the quartz filter was folded and placed in the glass cartridge. The glass cartridge was wrapped in aluminum foil, bubble wrapped, and placed in a glass bottle. The glass bottles were shipped to the offsite laboratory in coolers.

Source samples collected for SVOC analysis used a NIOSH-style XAD tube (8 mm x 10 mm flame sealed glass tube with 150 mg of XAD). A personal sampling pump was used during Phase A, and a critical flow orifice connected to a Thomas pump were used during Phase B, to pull samples through the XAD tube at 2 L/min. All personal sampling pumps and critical flow orifices were calibrated to determine exact flows.

To start sampling, the XAD tube ends were snapped and connected to the flux chamber or probe sampling manifold and the personal sampling pump or the critical flow orifice. The Thomas pump connected to the critical flow orifice (or the personal sampling pump) was started, and the start time was noted. If the XAD tube was connected to the flux chamber manifold, the flux chamber temperature was noted. To stop sampling, the personal sampling pump or the Thomas pump was stopped, and the stop time and flux chamber temperature were noted. The XAD tube was disconnected, capped, wrapped in aluminum foil, and taken to the trailer for shipment to the offsite laboratory in coolers.

3.4.3.3 Phenol Sampling

Ambient and process samples were collected by bubbling ambient air through two or three impingers in parallel, following EPA method TO-8. If three impingers were used, the first impinger contained 15 mL of distilled water for sample humidification, and the latter two contained 15 mL of 0.1 normal (N) sodium hydroxide. During the second half of Phase B sampling, ambient temperature declined, and the first impinger was found to be unnecessary. As a result, only two impingers with 15 mL of 0.1 N sodium hydroxide were used.

A 66-mL/min critical flow orifice was used to regulate the flow of air through the impingers for ambient and process samples. A 1.0-L/min flow rate was used for source samples. A Thomas pump operating at 15 inches or more of vacuum was used to pull ambient air through the critical flow orifice. For source samples, the nominal sample time was 70 minutes, providing a sample volume of approximately 70 liters; for ambient and process samples, sample time was nominally 23 hours (1,380 minutes), yielding a nominal sample volume of 90 liters. This sample volume is slightly higher than recommended in the method, so an additional humidification impinger was used early in the project to ensure that a sufficient absorbing solution was present in the impingers for the entire sample period. The impingers were charged in the sample trailer, capped, and then taken to the sample location and placed in the sample housing. The critical flow orifice was connected to an intake manifold system or probe sampling manifold housed in a sampling shelter. All critical flow orifices were calibrated to determine the exact flow rate.

To start sampling, the impingers were connected to the intake manifold or flux chamber and the Thomas pump. The Thomas pump was started, and the start time was noted. If the impingers were connected to the flux chamber manifold, the flux chamber temperature was noted. To stop sampling, the Thomas pump was stopped and the stop time was noted. The impingers were disconnected, capped, and taken to the trailer for recovery. The impinger solutions were collected in a bottle, and distilled water was used to rinse the impingers and the connecting U-tubes. The rinse solutions were collected in the same bottle. The bottle was capped and the liquid level was marked prior to shipment to the offsite laboratory for phenol analysis.

3.4.3.4 Formaldehyde Sampling

To collect the formaldehyde samples, air was pulled through a cartridge containing XAD resin coated with dinitrophenylhydrazine (DNPH). The same Thomas pump and intake manifold used for phenol sampling pulled air through the DNPH cartridge at a rate of 1 L/min using a critical flow orifice to regulate flow rate. All critical flow orifices were calibrated prior to use and sample volumes were calculated using the calibration flow rate values.

To start sampling, caps at both ends of the DNPH cartridge were removed and the DNPH cartridge was connected to the intake manifold and the Thomas pump. The Thomas pump was started, and the start time was noted. Temperatures were noted if flux chambers were used. To stop sampling, the Thomas pump was stopped, and the stop time was noted. The DNPH cartridge was disconnected,

capped, placed in an aluminum pouch, taken to the trailer for packaging, and shipped to the offsite laboratory for analysis.

3.4.3.5 Hydrogen Sulfide Sampling

H₂S samples were collected for ambient sampling using "ISC Method 701 – Determination of Hydrogen Sulfide Content of the Atmosphere." Samples were collected by bubbling ambient air through one impinger that contained 5 mL of ethanol and 10 mL of an alkaline suspension of cadmium hydroxide. The same Thomas pump and intake manifold used for phenol sampling pulled air through the impingers at 1 L/min using a calibrated critical flow orifice to regulate the flow rate.

The impingers were charged in the sample trailer, capped, and then taken to the sample location and placed in the sample housing. To begin sampling, the impinger was connected to an isolated section of the sampling manifold. The valves isolating the section from the rest of the manifold were opened, and the time was noted. To stop sampling, the valves were closed, the time was noted, and impinger disconnected, capped, and taken to the trailer for recovery. The impinger solutions were collected in a bottle and adsorbing solution and distilled water were used to rinse the impingers and the connecting U-tubes. The rinse solutions were collected in the same bottle. The bottle was capped, wrapped in foil, and the liquid level was marked prior to shipment to the offsite laboratory for hydrogen sulfide analysis.

3.4.3.6 Metal/TSP Sampling

Metals and TSP samples from process units were collected with the guidance of the EPA reference method for high-volume sampling, "Determination of Suspended Particulate Matter in the Atmosphere" (40 CFR Part 50, Appendix A). In this method, an air sampler draws a measured volume of air into a covered housing, and the entrained particulate matter is deposited onto a pre-tarred filter. Particulate matter concentrations are determined gravimetrically, then a portion of the TSP filter is digested in nitric acid to extract the metals, which are analyzed by inductively coupled plasma atomic emission spectroscopy (ICP).

Air samples for metals and TSP analysis were collected at a flow rate of approximately 40 cubic feet per minute (cfm) for a 6-hour period. The particle/metals filter was loaded into the high-volume sampler in the field. Prior to starting the sampling device, weather conditions were observed and recorded. The start time was noted and the sampler was started. During the sampling event, periodic inspections were made to verify proper system operation.

Upon the conclusion of the sampling period, the particle/metals filter was collected and returned to the trailer for packaging and shipment to the offsite laboratory.

3.4.3.7 Mercaptan Sampling

Samples were collected in 20-liter Tedlar bags using a Thomas pump for mercaptan analysis. The bag was purged twice with ambient air at the location before the actual sample was collected. The valve on the Tedlar bag was closed and taken to the trailer for shipment to the offsite laboratory in coolers. The first set of

bag samples taken were grab samples. Subsequent samples were collected with small sampling pumps using rotameters for controlling flow rates. The sampling flow rates were approximately 1 L/min, and the sample time was usually 10 to 12 minutes.

3.4.3.8 Jerome Hydrogen Sulfide Survey

All the "S" process locations were subjected to a H₂S survey using a Jerome® Hydrogen Sulfide analyzer. Prior to each survey, the Gold Film Hydrogen Sulfide Sensor® was regenerated in the trailer. The Jerome analyzer was given 1 minute to warm up at the first survey location to ensure that the instrument electronics had stabilized.

To start the survey, the Jerome analyzer was turned to the sampling mode by pressing the SAMPLE button. The measured concentration of H₂S displayed on the meter in ppb was recorded on a field data sheet after a constant volume was reached. The Jerome analyzer was taken to the next location, and the sampling sequence was repeated until all "S" locations had been surveyed. An internal calibration of the analyzer was conducted by the supplying laboratory prior to use in the field.

3.4.3.9 VOC-GC Bag Sampling

Tedlar bags were used at the sources to collect bag samples to be analyzed onsite by a GC. To collect a flux chamber bag sample, the rotameter connected to the excess flow line of the flux chamber was replaced by a Tedlar bag when the flux chamber was in operation. The bag was purged twice prior to collecting the sample. As soon as the bag was filled with sample, the bag was replaced by the rotameter and the valve on the bag was closed. A probe bag sample was collected by connecting the bag to the outlet of a Thomas pump pulling the probe sample. The bag was purged twice prior to collecting the sample. As soon as the bag was filled with sample, the valve on the bag was closed. The bag sample from either the probe or the flux chamber was immediately taken to the trailer for GC analysis.

3.4.4 Meteorological Data

Meteorological data collected during the sampling program was consistent with the *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV - Meteorological Measurements* (US EPA, 1989).

Meteorological data was collected at two locations using R.M. Young meteorological sensors (met towers) and Campbell CRID datalogger. Initially, met tower M1 was to be collocated with ambient station A8. Use of the location was not possible because the base radar test unit was conducting certain studies. M1 was relocated to a position close to the intersection of Douglas Blvd and Gate 21. Ambient station A8 was also moved.

Met tower M1 was equipped with a four-blade carbon fiber propeller coupled to a light chopper to measure wind speed, a wind vane to measure wind direction, a precision thermilinear probe to measure temperature, and a capacitance-type humidity sensor to measure relative humidity. A Campbell CR10 datalogger was

used to scan all the input channels at 1-second intervals to capture signals sent by the sensors. The wind speed and wind direction sensors were at a 10-meter height, and the temperature and relative humidity sensors were at a 2-meter height. Barometric pressure was measured at a 2-meter height using an electronic barometer.

Met tower M2 had sensors at the same height for wind speed, wind direction, and temperature. Relative humidity was not measured at this met tower. A Campbell CR10® datalogger was used to scan all the input channels at 1-second intervals to capture signals sent by the sensors.

Every morning at about 8:00 A.M. from Monday through Saturday, hourly average data from the datalogger memory modules at both M1 and M2 were downloaded to a computer. The downloaded data were available in ASCII hourly average format.

3.5 DECONTAMINATION

Decontamination was performed on sampling equipment and machinery to prevent contamination from sampling equipment and cross-contamination from one sampling location to the next.

During the soil gas survey, all equipment which had direct contact with the soil or sample including the probe, extensions, and syringes, was decontaminated using the following steps:

- Cleaned with a brush in a solution of laboratory-grade detergent (Alconox®) in potable water,
- Rinsed with potable water,
- Rinsed with deionized water,
- Allowed to air dry, and
- Wrapped in aluminum foil if not used immediately.

The deionized water was supplied by the Tinker AFB laboratory.

Drill rigs, drill pipe, and other equipment that did not come into contact with the sample medium were decontaminated before being moved to new sites. Decontamination of such equipment was accomplished by spraying with a high-pressure steam cleaner on a decontamination pad with holding areas to collect the fluids. Rinsates were then put into 55-gallon drums and labeled for appropriate disposal.

Soil and sediment sampling equipment which had direct contact with the samples received additional cleaning. This equipment included continuous-core samplers, split spoons, stainless-steel bowls, hand augers, and hand trowels. Decontamination of the sampling equipment consisted of the following steps:

- Cleaned with a brush in a solution of Alconox detergent in potable water,
- Rinsed with potable water,

- Rinsed with pesticide-grade isopropanol,
- Rinsed with ASTM Type II water,
- Allowed to air dry, and
- Wrapped in aluminum foil if not used immediately.

Air sampling equipment that was in contact with the sources was either decontaminated or disposed of. Flux chambers, probes, and equipment stands were decontaminated as follows:

- High pressure water rinse,
- Detergent wash, and
- Water rinse.

Rope and tubing were discarded after use. Impingers and PUF samplers were wiped with a degreaser and rinsed with water.

3.6 SURVEYING

Soil borings, soil gas, surface soil, and stream sediment locations were surveyed using Oklahoma State Planar Coordinates (OSPC) and the 1983 North American Datum (NAD). All surveying was performed by Delta Surveying and Engineering Company (Delta) of Oklahoma City, Oklahoma, under the supervision of a surveyor registered in Oklahoma. A control traverse and level loop were performed using existing on-base monuments and survey spikes.

All soil boring and soil gas locations were measured at ground level. All stream sediment coordinates were surveyed with reference to the base of the stream channel. Two permanent monuments were placed on either side of East Soldier Creek as points of reference for each sediment sampling location. A total of twelve monuments were set. The sampling location identification number and the date of the first sample collected were inscribed on a brass cap and permanently affixed to each monument.

3.7 MANAGEMENT OF INVESTIGATION-DERIVED WASTES

All soil cuttings and samples removed from the boreholes during drilling were placed in 55-gallon drums at the site. Each drum was properly labeled with the SWMU number and waste-generation date. The drums were then moved to a staging area at the inactive sludge drying beds until a determination could be made concerning final disposal. The drummed wastes were grouped by SWMU. Most of the drums contained cuttings from one boring; however, when sufficient space was available, the cuttings from two or more borings in the same SWMU were placed in a single drum. Based on the laboratory analysis of the soil boring samples, all soil cuttings were determined to be RCRA F001 hazardous waste.

After all of the borings were completed, one composite sample was collected from each SWMU group of drums. The samples were analyzed for toxicity characteristic leaching procedure (TCLP) metals and TCLP VOCs to determine if

treatment was necessary prior to disposal. After disposal characterization, all wastes were transported to a hazardous waste landfill for disposal. Prior to disposal, wastes will be treated as necessary in order to meet land disposal restriction (LDR) requirements.

Upon approval from base personnel, rinsate water from equipment decontamination and steam cleaning operations was discharged into the recirculation pit for treatment at the Tinker AFB IWTP. Ancillary wastes such as plastic sheeting and surface concrete were disposed of in 55-gallon drums and segregated from the drill cutting wastes.

3.8 LABORATORY ANALYSIS

3.8.1 Overview

The analytical program used to support the RFI at Tinker AFB involved field laboratories, three offsite laboratories, and numerous analytical procedures. Field laboratories provided qualitative real-time data, and the offsite laboratories provided quantitative physical and chemical data. This section names the laboratories used and the analytical methods used by each. The site-specific results from each analysis are included in section 4. This section also presents a brief overview of the QA/QC procedures used during the project to ensure the quality of the analytical data. A full discussion of the QA/QC protocol and results of the data validation are in the QA report (appendix J).

3.8.2 Field Laboratories

3.8.2.1 Soil Gas

ES provided a mobile laboratory which conducted EPA data-objective Level II analyses for selected VOCs in soil gas on a 24-hour-turnaround schedule. The VOCs targeted in the analysis were:

- Vinyl chloride
- 1,1-Dichloroethene
- total 1,2-Dichloroethene
- Trichloroethane
- 1,2-Dichloroethane
- Benzene
- Trichloroethene
- Toluene
- 1,1,2,2-Tetrachloroethene
- Ethylbenzene
- total Xylenes

The samples were analyzed using a modified EPA method 8010/8020. A model HNU 321 GC equipped with a 30-meter medium-polarity megabore capillary column and dual detectors in series was used for analysis. The detectors were a 10.6-electron volt (eV) PID and a FID. A 1.0-mL aliquot of the sample from the syringe was injected into the GC using a 1.0-mL sample loop. The sample results were logged on laboratory data form 1, which are compiled in appendix E.

3.8.2.2 Air

ES also provided a mobile laboratory to analyze air samples for certain target VOC compounds. The screening data aided in the selection of sources to be

sampled during Phase B, as a check of SUMMA sampling results, and to provide a database for later evaluation of the technique as an emission measurement procedure.

The instrument used for onsite analysis of VOCs in air was a Varian® 3400 GC with a FID and a heated gas sampling loop. The chromatographic column used was a DB-624 "megabore" capillary column made by J&W Scientific Company having a bore size of 0.53 millimeters and a length of 30 meters. For data collection and processing, the GC interfaced with an Everex® 386 personal computer equipped with Varian Star Workstation software.

Samples collected in Tedlar bags were introduced into the GC by drawing the contents of the bag into a heated sample loop via a vacuum pump. A pneumatic valve was used to direct the contents of the sample loop to the GC column. Calibration standards, check standards, and blanks were also analyzed from Tedlar bags.

3.8.3 Offsite Laboratories

The chemical analyses performed in support of the RFI are listed in Table 3.6. These analyses were selected to evaluate the concentrations of potentially hazardous constituents at the site. Geophysical tests were performed to obtain data for remedial engineering design.

The offsite chemical analyses of the wastewater, soil, and sediment samples were performed by Southwestern Laboratories of Oklahoma, Inc. (Southwestern). The target compound list for analyses performed by Southwestern and the levels of detection for each analyte are given in Table 3.7. All of the analyses were performed using standard EPA methods.

The geophysical laboratory used was PSI in Oklahoma City, Oklahoma. The samples were tested for Atterburg limits, moisture content, bulk density, organic content, and constant head permeability. All tests were completed using standard ASTM methods (Table 3.6).

3.8.4 Quality Assurance/Quality Control (QA/QC)

The entire sampling and analysis program was subject to QA/QC requirements to ensure that the data generated during the RFI were valid. A summary of the methods used for QA/QC is presented here. A full discussion of the project QA/QC program is presented in the QA report (appendix J).

The purpose of the QA/QC program is to determine the level of data quality necessary to accomplish the goals of the RFI, and to design and carry out a sampling and analysis program which meets those goals. These goals, known as data quality objectives (DQOs), are measured using the criteria of precision, accuracy, representativeness, comparability, and completeness. DQOs were developed as part of the work plan process (ES, 1993b) and are evaluated in the QA report (appendix J).

Table 3.6
Methods of Chemical Analysis for Soil, Water, and Air Samples
Tinker AFB, Oklahoma

Analysis	Method Number	Matrix	Reference
Volatile organic compounds	SW-8240*	Soil	1
	EPA TO14	Air	2
	Modified EPA 18	Air	3
Semivolatile organic compounds	SW-3520/SW-3550/ SW-8270	Soil and Water	1
	EPA TO10	Air	2
	EPA TO13	Air	2
Total petroleum hydrocarbons	SW-8015	Soil and Water	
Metals**	SW-3050/SW-6010	Soil and Water	1
Mercaptan	EPA TO14	Air	
Mercury	SW-3050/SW-7471	Soil and Water	1
Hydrogen sulfide	EPA ISC701	Air	
Silver	SW-3050/SW-7761	Soil and Water	1
PCBs	SW-3550/SW-3510/ SW-8080	Soil	1
Cyanide, total	SW-3050/SW-9010	Soil	1
Formaldehyde	EPA TO11	Air	2
Phenols	EPA TO8	Air	2
Total suspended particulates	40CFR50	Air	
Bulk density	ASTM D2937	Soil	4
Permeability	ASTM D2434	Soil	4
Atterberg limits	ASTM D4318	Soil	4
Particle size	ASTM D422	Soil	4
Soil moisture	ASTM D2216	Soil	4
Organic content	ASTM D2970	Soil	4

References:

1. U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste*, SW-846, 1986.
2. EPA Compendium Methods for Analysis of Toxic Organic Compounds in Ambient Air.
3. EPA Method 18, 40 CFR Part 60, Appendix A.
4. American Society for Testing and Materials, *1993 Annual Book of Standards*.

* For GC/MS VOC analysis, SWLO uses SW-8240 with the microbore column of SW-8260.

** Metals are arsenic, barium, cadmium, chromium, lead, nickel, selenium, silver, and zinc.

Table 3.7
Analytical Methods and Limits of Detection (LOD)
Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-8080 - PCBs ($\mu\text{g/L}$ and mg/kg)				
PCB-1016	0.5	0.03	0.1	0.0010
PCB-1221	0.5	0.04	0.1	0.0013
PCB-1232	0.5	0.01	0.1	0.0003
PCB-1242	0.5	0.01	0.1	0.0003
PCB-1248	0.5	0.04	0.1	0.0013
PCB-1254	1.0	0.05	0.2	0.0017
PCB-1260	1.0	0.04	0.2	0.0013
SW-8240 - Volatile Organic Compounds ($\mu\text{g/L}$ and $\mu\text{g/kg}$)				
Acetone	50.0	1.89	100.0	3.71
Benzene	3.0	0.77	100.0	1.21
Bromodichloromethane	5.0	2.54	100.0	0.66
Bromoform	5.0	3.67	100.0	2.54
Bromomethane	10.0	1.04	100.0	2.75
2-Butanone (MEK)	50.0	8.84	100.0	3.90
Carbon disulfide	3.0	0.74	100.0	1.41
Carbon tetrachloride (Freon 10)	3.0	0.51	100.0	1.24
Chlorobenzene	5.0	0.45	100.0	0.79
Chloroethane	10.0	1.21	100.0	2.78
2-Chloroethyl vinyl ether	10.0	4.65	100.0	7.68
Chloroform	5.0	0.91	100.0	1.28
Chloromethane	10.0	0.40	100.0	1.92
Dibromochloromethane (chlorodibromomethane)	5.0	2.50	100.0	1.38
1,2-Dichlorobenzene	NA	-	NA	-
1,3-Dichlorobenzene	NA	-	NA	-
1,4-Dichlorobenzene	NA	-	NA	-

1 Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services).

Table 3.7 (continued)
Analytical Methods and Limits of Detection (LOD)
Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-8240 - Volatile Organic Compounds (µg/L and µg/kg)				
1,1-Dichloroethane	5.0	0.50	100.0	1.62
1,2-Dichloroethane	5.0	1.38	100.0	2.84
1,1-Dichloroethene	3.0	1.10	100.0	1.08
trans-1,2-Dichloroethene	5.0	0.99	100.0	1.17
Dichlorodifluoromethane	NA	-	100.0	1.74
1,2-Dichloropropane	5.0	1.31	100.0	0.97
cis-1,3-Dichloropropene	5.0	2.22	100.0	0.99
trans-1,3-Dichloropropene	5.0	2.26	100.0	0.87
Ethylbenzene	5.0	0.55	100.0	2.59
2-Hexanone	50.0	1.50	100.0	4.82
Methylene chloride	5.0	0.96	100.0	2.13
4-Methyl-2-pentanone (MIBK)	50.0	2.13	100.0	3.97
Methyl Tert Butyl Ether (MTBE)	NA	-	100.0	0.37
Styrene	5.0	0.78	100.0	0.87
1,1,2,2-Tetrachloroethane	5.0	3.67	100.0	1.70
Tetrachloroethene	3.0	0.75	100.0	1.29
Toluene	5.0	0.43	100.0	0.93
1,1,1-Trichloroethane	5.0	0.59	100.0	0.61
1,1,2-Trichloroethane	5.0	2.20	100.0	1.11
Trichloroethene	3.0	0.43	100.0	1.12
1,1,2-Trichloro-Trifluoroethene (Freon 113)	NA	-	100.0	1.20
Trichlorofluoromethane	NA	-	100.0	1.19
Vinyl acetate	50.0	2.63	100.0	4.86
Vinyl chloride	10.0	0.79	100.0	1.93
Total Xylenes (o)	5.0	0.57	100.0	0.96
Total Xylenes (m, p)	5.0	0.63	100.0	1.66

¹ Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services)

Table 3.7 (continued)
Analytical Methods and Limits of Detection (LOD)
Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-8270 - Semivolatile Organic Compounds ($\mu\text{g/L}$ and $\mu\text{g/kg}$)				
<u>Base/Neutral Extractables</u>				
Acenaphthene	10.0	3.34	500.0	37.3
Acenaphthylene	10.0	3.33	500.0	28.9
Aniline	50.0	NA	2500.0	NA
Anthracene	10.0	2.38	500.0	55.6
Benzo(a)anthracene	10.0	1.43	500.0	28.0
Benzo(b)fluoranthene	10.0	1.36	500.0	142
Benzo(k)fluoranthene	10.0	2.16	500.0	166
Benzo(g,h,i)perylene	10.0	1.64	500.0	65.9
Benzo(a)pyrene	10.0	0.86	500.0	31.3
Benzyl alcohol	20.0	3.85	1000.0	80.9
bis(2-Chloroethoxy)methane	10.0	3.25	500.0	34.6
bis(2-Chloroethyl)ether	10.0	4.01	500.0	62.6
bis(2-Chloroisopropyl)ether	10.0	4.61	500.0	195
bis(2-Ethylhexyl)phthalate	10.0	1.49	500.0	90.9
4-Bromophenyl phenyl ether	10.0	2.77	500.0	96.2
Butyl benzyl phthalate	10.0	1.77	500.0	86.3
4-Chloroaniline	20.0	9.83	1000.0	200
2-Chloronaphthalene	10.0	3.24	500.0	33.3
4-Chlorophenyl phenyl ether	10.0	3.57	500.0	60.6
Chrysene	10.0	1.65	500.0	27.0
Dibenz(a,h)anthracene	10.0	1.95	500.0	80.9
Dibenzofuran	10.0	3.21	500.0	28.3
Di-n-Butylphthalate	10.0	2.77	500.0	43.0
1,2-Dichlorobenzene	5.0	3.59	500.0	64.6
1,3-Dichlorobenzene	5.0	3.04	500.0	56.9
1,4-Dichlorobenzene	5.0	3.10	500.0	54.6
3,3'-Dichlorobenzidine	20.0	20.0	500.0	500
Diethyl phthalate	20.0	2.91	500.0	37.3
Dimethyl phthalate	10.0	2.44	500.0	25.0

1 Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services).

Table 3.7 (continued)
Analytical Methods and Limits of Detection (LOD)
Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-8270 - Semivolatile Organic Compounds ($\mu\text{g/L}$ and $\mu\text{g/kg}$)				
<u>Base/Neutral Extractables</u> (continued)				
2,4-Dinitrotoluene	10.0	2.10	500.0	45.6
2,6-Dinitrotoluene	10.0	2.91	500.0	39.3
Di-n-octyl phthalate	10.0	1.96	500.0	223
Fluoranthene	10.0	1.21	500.0	40.6
Fluorene	10.0	2.97	500.0	30.0
Hexachlorobenzene	10.0	2.15	500.0	95.2
Hexachlorobutadiene	10.0	2.95	500.0	77.6
Hexachlorocyclopentadiene	10.0	NA	500.0	259
Hexachloroethane	10.0	2.79	500.0	52.3
Indeno(1,2,3-cd)pyrene	10.0	1.54	500.0	67.3
Isophorone	10.0	3.03	500.0	46.3
1-Methylnaphthalene	NA	-	NA	-
2-Methylnaphthalene	10.0	3.29	500.0	28.9
Naphthalene	10.0	3.73	500.0	44.6
2-Nitroaniline	NA	-	NA	-
3-Nitroaniline	50	2.49	2500.0	163
4-Nitroaniline	50	2.10	2500.0	88.6
Nitrobenzene	10	3.58	500.0	21.0
n-Nitrosodiphenylamine	10	1.95	2500.0	31.0
n-Nitroso-di-n-propylamine	10	2.81	500.0	100
Phenanthrene	10	2.31	500.0	43.3
Pyrene	10	1.57	500.0	91.6
1,2,4-Trichlorobenzene	10	2.89	500.0	51.9

¹ Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services).

Table 3.7 (continued)
Analytical Methods and Limits of Detection (LOD)
Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-8270 - Semivolatile Organic Compounds ($\mu\text{g/L}$ and $\mu\text{g/kg}$)				
<u>Acid Extractables</u>				
Benzoic Acid	50	6.64	2500.0	68.9
4-Chloro-3-methylphenol	10.0	3.21	500.0	41.2
2-Chlorophenol	10.0	3.99	500.0	64.9
2,4-Dichlorophenol	10.0	3.68	500.0	42.3
2,4-Dimethylphenol	10.0	4.81	500.0	77.6
4,6-Dinitro-2-methylphenol	50.0	2.51	1500.0	67.9
2,4-Dinitrophenol	50.0	2.58	1500.0	86.9
2-Methylphenol	10.0	4.26	500.0	22.6
4-Methylphenol	10.0	4.01	500.0	59.6
2-Nitrophenol	10.0	3.46	500.0	28.6
4-Nitrophenol	50.0	2.31	2500.0	67.6
Pentachlorophenol	30.0	2.00	1500.0	287
Phenol	10.0	3.73	500.0	74.9
2,4,5-Trichlorophenol	50.0	3.44	1500.0	82.9
2,4,6-Trichlorophenol	10.0	3.52	500.0	53.6
SW-6010 - Metals ($\mu\text{g/L}$ and mg/kg)				
Arsenic	300.0	45.0	NA	-
Barium	100.0	3.36	NA	-
Cadmium	5.0	2.11	NA	-
Chromium	30.0	9.50	NA	-
Lead	200.0	41.4	NA	-
Nickel	40.0	18.2	NA	-
Selenium	400.0	108	NA	-
Zinc	10.0	10.0	NA	-

¹ Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services).

Table 3.7 (continued)
 Analytical Methods and Limits of Detection (LOD)
 Tinker AFB, Oklahoma

Method Number and Description/Analyte	Water Samples		Soil Samples	
	Maximum LODs ¹	SWLO LODs	Maximum LODs ¹	SWLO LODs
SW-6010 - Metals ($\mu\text{g/L}$ and mg/kg) (continued)				
SW-7471 - Mercury ($\mu\text{g/L}$ and mg/kg)	5.0	0.02	NA	-
SW-7761 - Silver ($\mu\text{g/L}$ and mg/kg)	NA	-	0.5	0.5
SW-9010 - Total Cyanide ($\mu\text{g/L}$ and mg/kg)	NA	-	20.0	NA
SW-8015 - Modified TPH ($\mu\text{g/L}$ and mg/kg)				
Gasoline	NA	-	NA	-
Diesel	NA	-	NA	-

¹ Maximum LODs are specified in the Statement of Work for A-E Environmental Services, Tinker AFB, March 1993.

NA Not applicable (not specified in the statement of work for A-E Environmental Services).

Precision is defined as the measurement of agreement between multiple measurements of the same sample, without assumption of any prior information on the true result. Precision is evaluated by collecting and analyzing duplicate samples.

Accuracy, the measure of the nearness to the true value of a result, is assessed by means of reference samples and percent recovery. Accuracy is usually evaluated with matrix spikes, laboratory control samples, and surrogates.

Representativeness expresses the degree to which the sample data accurately and precisely represent conditions at the sampling location. Representativeness is addressed by describing sampling techniques, the rationale used to select sampling locations, decontamination procedures, and sample handling and custody procedures.

Completeness is a measure of the amount of usable data resulting from a data collection activity. It is measured by comparing the number of actual valid results with the number of results theoretically attainable.

Comparability is a measure of the confidence with which one data set can be compared to another. Comparability is assured through the use of standardized sampling and analytical procedures.

3.8.5 Data Validation

The chemical analytical data generated by the offsite laboratories during the RFI underwent a formal data validation process to assure the quality of the data. The level of QA/QC for the offsite laboratory data was EPA QA/QC Level III. Data generated by the field laboratories did not undergo a validation process.

SECTION 4

INVESTIGATION RESULTS

This section presents the findings of the RFI at twenty SWMUs and the recirculation pit associated with the WWTF at Tinker AFB and discusses the investigations performed at each site. The RFI included influent lift station sampling, soil gas surveys, soil and sediment sampling, and air sampling. The soil sampling data presented below include the results of metals analysis. These results are compared to a range of background concentrations presented in a United States Geological Service (USGS) report (USGS, 1991). Appendices K and L contain the laboratory data sheets for wastewater, sediment, and soil samples.

The data presented in the tables in this section have been annotated with validation qualifiers. The qualifiers indicate the analyte was positively identified; however, the measured concentration may not be the true concentration. A complete discussion of the results of the data validation can be found in appendix J for soil and water data, and in appendix M for air data. The following qualifiers were used in this report:

- J₁ Indicates the analyte was also found in the associated blank(s). The results may have a high bias and/or false positive.
- J₂ Indicates the calibration range has been exceeded and the sample was not diluted and reanalyzed. There may be a low bias in the concentration value. There are three reasons for not conducting a reanalysis: (1) the concentration barely exceeded the upper calibration range, (2) not enough sample, and (3) the reanalysis would exceed the holding time.
- J₃ Indicates the holding time was exceeded. The bias depends on the analyte and preservation used. This qualifier was used for some samples which were reanalyzed after the holding time.
- J₄ Indicates other QC criteria exceeded control limits and the bias is not readily determined. The QC criteria commonly exceeded are percent recovery for spiking compounds and relative percent differences for duplicate results.
- J₅ Indicates the value is above the method detection limit but lies below the method quantitation limit. The method quantitation limit is the value which can be reliably measured and is numerically defined as 1 2/3 times the MDL. The analyte was detected but below quantitation limits.
- J₆ Indicates the data has been qualified for more than one reason.

R Indicates the data are unusable due to the severity of the QA/QC excursions. A resampling would be necessary to confirm or deny the presence of the analyte.

In addition to the above qualifiers, some analyte results are reported in the tables and marked with a "†." These analytes have been positively identified at concentrations below the statistical method detection limit.

4.1 INFLUENT LIFT STATION SAMPLING

The industrial wastewater from the influent lift stations was sampled in two successive events, one week apart, to characterize the IWTP influent. The results are summarized in Tables 4.1 and 4.2. The units have been changed in the following discussion where necessary to simplify discussion. Overall, the constituents detected in the samples collected during the first sampling episode were also detected in the samples collected in the second event, one week later.

The most prevalent VOC detected at the IWTP is methylene chloride, detected in nearly every sample. The greatest concentration of methylene chloride was found in the first-round sample collected at the new lift station 6 (1,300 mg/L). The new lift station 6 first-round sample also contained a significant amount of 1,1,1-trichloroethane (26 mg/L). The sample from the lift station at building 3221 contained the least amount of VOCs, with only a trace of methylene chloride (9.6 µg/L) in the first sample and trace levels of acetone, MEK, and methylene chloride in the second sample.

All of the lift station samples collected in the first round contained phenol, except the sample from lift station 10. The highest concentration of phenol, 3,000 mg/L, was detected in the sample from new lift station 6. Other samples in the first collection containing high concentrations of phenol include old lift station 6, building 2280, and building 2127, containing 120 mg/L, 16 mg/L, and 11 mg/L, respectively. Other SVOCs detected in the wastewater samples include naphthalene (8.2 mg/L, IWTL510), 2-methylnaphthalene (17 mg/L, IWTL510), and benzyl alcohol (750 mg/L, IWTL56 new). Gasoline was detected in every sample except the samples from lift stations at building 3221 and building 2211.

Barium, chromium, and zinc were the most prevalent metals detected in the samples collected on November 3 and 4, 1993. Barium concentrations ranged from 449 µg/L in the sample from lift station 2 to 1,040 µg/L in the lift station at building 2280. At new lift station 6, chromium was detected at 85,800 µg/L.

The second round of wastewater samples was collected on November 10 and 11, 1993 (Table 4.2). Compounds detected in the second round samples include vinyl chloride and carbon disulfide in the sample from the lift station at building 3001. Methylene chloride, PCE, and 2-butanone (MEK) were detected at higher concentrations than the other VOCs in the second round of samples.

Jet fuels, JP-4 and JP-5 (kerosene) were detected at lift stations 2, 10, and the lift station at building 3001 at concentrations of 9.48 mg/L, 994 mg/L, and 1,120 mg/L, respectively. Gasoline was detected in most of the lift station samples.

Table 4.1
Chemical Constituents Detected in Wastewater, November 4, 1993
Lift Stations
Tinker AFB, Oklahoma

Chemical	Sample Identification					
	IWTLS2	IWTLS2D ¹	IWTBG3221	IWTLS3	IWTLS10	IWTBG3001
Volatile organic compounds (µg/L):						
Acetone	ND	ND	ND	ND	ND	180
Benzene	ND	ND	ND	ND	62	ND
2-Butanone (MEK)	930 (J ₄)	1900 (J ₄)	ND	ND	94 (J ₆)	ND
Chloroform	82 (J ₆)	240 (J ₆)	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	23 (J ₅)	31
1,2-Dichloroethene (total)	65	72	ND	ND	ND	140
Ethyl benzene	ND	ND	ND	ND	69	1.6 (J ₅)
Methylene chloride	980 (J ₆)	760 (J ₆)	9.6 (J ₆)	9500 (J ₆)	38 (J ₆)	25 (J ₆)
Tetrachloroethene (PCE)	1700	1100	ND	110 (J ₄)	24 (J ₄)	29 (J ₄)
Toluene	12 (J ₁)	15 (J ₁)	ND	3100 (J ₁)	89 (J ₁)	12 (J ₁)
1,1,1-Trichloroethane	14 (J ₆)	31 (J ₆)	ND	290 (J ₄)	33 (J ₄)	28 (J ₄)
Trichloroethene (TCE)	37 (J ₅)	43 (J ₅)	ND	ND	ND	11
Xylene	ND	ND	ND	150 (J ₁)	500 (J ₁)	24 (J ₁)
Semivolatle organic compounds (µg/L):						
Benzo(a)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	2 (J ₅)
4-Chloro-3-methylphenol	ND	ND	10 (R)	ND	ND	ND
2-Chlorophenol	ND	ND	10 (R)	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	450 (J ₅)	1 (J ₅)†
1,2-Dichlorobenzene	50 (J ₆)	35 (J ₆)	ND	1 (J ₆)†	ND	75 (J ₆)
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	7 (J ₆)
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	16 (J ₆)
2,4-Dichlorophenol	ND	ND	10 (R)	ND	ND	ND
2,4-Dimethylphenol	56 (J ₆)	38 (J ₆)	10 (R)	ND	ND	6 (J ₆)
4,6-Dinitro-2-methylphenol	ND	ND	10 (R)	ND	ND	ND
2,4-Dinitrophenol	ND	ND	50 (R)	ND	ND	ND
bis (2-Ethylhexyl)phthalate	ND	6 (J ₅)	50 (R)	13	ND	64

Table 4.1, continued

Chemical	Sample Identification					
	IWTLS2	IWTLS2D ¹	IWTBG3221	IWTLS3	IWTLS10	IWTBG3001
Fluoranthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	1 (J5) [†]	ND	ND
2-Methylnaphthalene	ND	12 (J5)	ND	5 (J5)	17000	20
2-Methylphenol (o-cresol)	280 (J6)	230 (J6)	1 (J6) [†]	2 (J6) [†]	ND	ND
4-Methylphenol (p-cresol)	300 (J6)	240 (J6)	2 (J6) [†]	2 (J6) [†]	ND	55 (J6)
Naphthalene	ND	ND	ND	4 (J5)	8200	9 (J5)
2-Nitrophenol	ND	10 (J6)	10 (R)	4 (J6)	ND	ND
4-Nitrophenol	ND	10 (J6)	50 (R)	ND	ND	ND
di-n-Octyl phthalate	ND	ND	ND	2 (J5)	ND	ND
Pentachlorophenol	ND	ND	50 (R)	ND	ND	ND
Phenol	3800 (J6)	4800 (J6)	22 (J6)	4 (J6)	ND	120 (J6)
Pyrene	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	10 (R)	ND	ND	ND
Total purgeable hydrocarbons (µg/L):						
Gasoline	143	125	ND	12000	5070	1500
Total extractable hydrocarbons (µg/L):						
Diesel C10-C22	ND	ND	ND	6590 (J4)	ND	ND
Kerosene C9-C18	ND	ND	ND	ND	4590000 (J6)	ND
Miscellaneous C7	NA	NA	NA	NA	NA	NA
Miscellaneous C7-C24	5950 (J4)	7030 (J4)	NA	NA	NA	7160 (J4)
Miscellaneous C8-C24	NA	NA	170 (J4)	NA	NA	NA
Miscellaneous C12-C24	NA	NA	NA	NA	NA	NA
#6 Fuel oil C12-C24	ND	ND	ND	ND	ND	ND
Metals (µg/L):						
Barium	468	449	468	505	541	583
Cadmium	35.2	31.1	ND	13.5	3.3	ND
Chromium	650 (J6)	800 (J6)	24.3 (J6)	25 (J6)	7.3 (J6)	16 (J6)
Lead	19.6	16.3	34.6	4.8	ND	ND
Mercury	ND	ND	ND	ND	ND	ND
Nickel	114	87.1	11.2	ND	ND	ND
Silver	5.4	3.7	ND	ND	ND	ND
Zinc	49.8	44.8	63.1	41.3	68.9	36.4

Table 4.1 continued

Chemical	Sample Identification				
	IWTBG2280	IWTBG2211	IWTBG2127	IWTLS6NEW	IWTLS6OLD
Volatile organic compounds ($\mu\text{g/L}$):					
Acetone	770	ND	570	ND	790
Benzene	ND	ND	ND	ND	ND
2-Butanone (MEK)	2200 (J ₆)	83 (J ₆)	1300 (J ₆)	ND	1700 (J ₆)
Chloroform	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND
1,2-Dichloroethene (total)	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND
Methylene chloride	2500 (J ₆)	ND	960 (J ₆)	1300000 (J ₆)	1700 (J ₆)
Tetrachloroethene (PCE)	ND	ND	ND	ND	ND
Toluene	51 (J ₁)	ND	39 (J ₁)	ND	34 (J ₁)
1,1,1-Trichloroethane	ND	7.7 (J ₄)	ND	26000 (J ₄)	ND
Trichloroethene (TCE)	ND	ND	ND	ND	ND
Xylene	39 (J ₁)	ND	19 (J ₁)	ND	14 (J ₁)
Semivolatile organic compounds ($\mu\text{g/L}$):					
Benzo(b)fluoranthene	ND	ND	8 (J ₅)	ND	ND
Benzo(k)fluoranthene	ND	ND	7 (J ₅)	ND	ND
Benzoic acid	280 (J ₅)	ND	ND	ND	4500 (J ₅)
Benzyl alcohol	ND	ND	120	750000	1500 (J ₅)
Butyl benzyl phthalate	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND
bis (2-Ethylhexyl)phthalate	ND	2 (J ₅)	280	ND	ND
Fluoranthene	ND	ND	13 (J ₅)	ND	ND
Fluorene	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	11 (J ₅)	ND	ND
2-Methylphenol (o-cresol)	ND	ND	70 (J ₆)	ND	ND
4-Methylphenol (p-cresol)	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND
di-n-Octyl phthalate	ND	ND	16 (J ₅)	ND	ND

Table 4.1 continued

Chemical	Sample Identification				
	IWTBGS2280	IWTBGS2211	IWTBGS2127	IWTLS6NEW	IWTLS6OLD
Pentachlorophenol	ND	ND	ND	ND	ND
Phenol	16000 (J ₆)	9 (J ₆)	11000 (J ₆)	3000000 (J ₆)	120000 (J ₆)
Pyrene	ND	ND	13 (J ₅)	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
Total purgeable hydrocarbons (µg/L):					
Gasoline	1030	ND	384	1230	699
Total extractable hydrocarbons (µg/L):					
Diesel C10-C22	ND	ND	ND	ND	ND
Kerosene C9-C18	ND	ND	ND	ND	ND
Miscellaneous C7	NA	106 (J ₄)	NA	NA	NA
Miscellaneous C7-C24	17900 (J ₄)	ND	9410 (J ₄)	897000 (J ₄)	28400 (J ₄)
Miscellaneous C8-C24	NA	NA	NA	NA	NA
Miscellaneous C12-C24	NA	NA	NA	NA	NA
#6 Fuel oil C12-C24	ND	876 (J ₄)	ND	ND	ND
Metals (µg/L):					
Barium	1040	553	904	561	763
Cadmium	78.3	11.7	53.9	166	43.8
Chromium	3770 (J ₆)	10.4 (J ₆)	1800 (J ₆)	85800 (J ₆)	1830 (J ₆)
Lead	35.1	4.1	436	56	553
Mercury	ND	ND	0.93	ND	ND
Nickel	ND	ND	31.9	ND	ND
Silver	ND	ND	ND	3.9	ND
Zinc	1300	57.5	1470	531	433

ND = not detected.

NA = not applicable.

¹ IWTLS2D is a duplicate of IWTLS2.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positive.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

The R data qualifier indicates that the data is unusable for all purposes. The analyte was analyzed for but the presence of the analyte has not been verified.

Table 4.2
Chemical Constituents Detected in Wastewater, November 10-11, 1993
Lift Stations
Tinker AFB, Oklahoma

Chemical	Sample Identification					
	IWTLS2	IWTLS2D ¹	IWTBG3221	IWTLS3	IWTLS10	IWTBG3001
Volatile organic compounds (µg/L):						
Acetone	1000 (J ₆)	340 (J ₆)	33 (J ₆)	260 (J ₆)	14 (J ₆)	16 (J ₆)
Benzene	ND	ND	ND	ND	47	ND
2-Butanone (MEK)	ND	140	36	ND	ND	7.4 (J ₅)
Carbon disulfide	ND	ND	ND	ND	2.3 (J ₅)	1.1 (J ₅)
Chloroform	110 (J ₅)	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	11	21
1,1-Dichloroethene	ND	9.4 (J ₅)	ND	ND	ND	ND
1,2-Dichloroethene (total)	1500	48	ND	ND	ND	89
Ethyl benzene	ND	1.5 (J ₅)	ND	ND	48	2.4 (J ₅)
Methylene chloride	ND	110	16	660	ND	4.1 (J ₅)
Tetrachloroethene (PCE)	7200 (J ₄)	640 (J ₄)	ND	46 (J ₄)	24 (J ₄)	10 (J ₄)
Toluene	1200	38	4 (J ₅)	ND	160	5.3
1,1,1-Trichloroethane	ND	ND	ND	57	67	19
Trichloroethene (TCE)	290 (J ₅)	16 (J ₅)	ND	ND	ND	5.1
Vinyl chloride	ND	ND	ND	ND	ND	16
Xylene	140 (J ₅)	8.7 (J ₅)	ND	11 (J ₅)	400 (J ₂)	34
Semivolatile organic compounds (µg/L):						
Benzoic acid	89 (J ₆)	8.3 (J ₆)	1.2 (J ₆) [†]	64 (J ₆)	ND	ND
Benzyl alcohol	46 (J ₆)	ND	34 (J ₃)	1.3 (J ₆) [†]	ND	ND
Dibenzofuran	ND	ND	ND	ND	30 (J ₆)	95 (J ₆)
1,2-Dichlorobenzene	98 (J ₃)	4.5 (J ₆)	ND	ND	ND	ND
1,3-Dichlorobenzene	33 (J ₆)	1 (J ₆) [†]	ND	ND	ND	ND
1,4-Dichlorobenzene	46 (J ₆)	1.3 (J ₆) [†]	ND	ND	ND	ND
Diethyl phthalate	5 (J ₆)	1.2 (J ₆) [†]	ND	1.8 (J ₆) [†]	ND	ND
2,4-Dimethylphenol	33 (J ₆)	7.2 (J ₆)	ND	5.2 (J ₆)	ND	ND
bis(2-Ethylhexyl)phthalate	16 (J ₆)	3 (J ₆)	1 (J ₆) [†]	17 (J ₃)	ND	ND
Fluoranthene	13 (J ₆)	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	34 (J ₆)
2-Methylnaphthalene	76 (J ₃)	3.8 (J ₆)	ND	3 (J ₆) [†]	970 (J ₃)	2700 (J ₃)
2-Methylphenol (o-cresol)	57 (J ₃)	ND	ND	ND	ND	ND
4-Methylphenol (p-cresol)	42 (J ₆)	ND	ND	3 (J ₆) [†]	110 (J ₆)	ND
Napthalene	16 (J ₆)	ND	ND	ND	750	1300 (J ₃)

Table 4.2, cont.

Chemical	Sample Identification					
	IWTLS2	IWTLS2D ¹	IWTBG3221	IWTLS3	IWTLS10	IWTBG3001
di-n-Octyl phthalate	12 (J ₆)	1.5 (J ₆)†	ND	7.1 (J ₆)	ND	ND
Phenanthrene	9.1 (J ₆)	ND	ND	ND	ND	28 (J ₆)
Phenol	110 (J ₆)	4.3 (J ₆)	21 (J ₆)	9.3 (J ₆)	ND	ND
Pyrene	6.8 (J ₆)	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND
Total purgeable hydrocarbons (µg/L):						
Gasoline	35.6 (J ₅)	ND	ND	135	3460	176
Total extractable hydrocarbons (µg/L):						
Diesel C10-C22	ND	ND	ND	ND	ND	ND
Kerosene C9-C18	9480 (J ₄)	4210 (J ₄)	ND	ND	994000 (J ₄)	1120000 (J ₄)
Miscellaneous C7	ND	ND	NA	NA	ND	ND
Miscellaneous C7-C24	ND	ND	660	3160	ND	ND
Miscellaneous C12-C24	ND	ND	NA	NA	ND	ND
Metals (µg/L):						
Barium	821 (J ₄)	352 (J ₄)	417 (J ₄)	438 (J ₄)	617 (J ₄)	434 (J ₄)
Cadmium	76.4 (J ₄)	25.4 (J ₄)	ND	27.9 (J ₄)	ND	ND
Chromium	2430	1470	484	36.9	15	19.6
Lead	2690 (J ₄)	12.2 (J ₄)	ND	49.1 (J ₄)	ND	ND
Mercury	ND	ND	ND	ND	ND	ND
Nickel	1810 (J ₄)	694 (J ₄)	ND	11.9 (J ₄)	ND	ND
Selenium	ND	ND	ND	ND	ND	ND
Silver	3.3	3.1	ND	ND	ND	ND
Zinc	866 (J ₄)	51.9 (J ₄)	15.3 (J ₄)	60.4 (J ₄)	90.6 (J ₄)	19.2 (J ₄)

Table 4.2 continued

Chemical	Sample Identification				
	IWTBG2280	IWTBG2211	IWTBG2127	IWTLS6NEW	IWTLS6OLD
Volatile organic compounds ($\mu\text{g/L}$):					
Acetone	ND	16 (J ₆)	340 (J ₆)	ND	550 (J ₆)
Benzene	ND	ND	ND	ND	ND
2-Butanone	12000	ND	230	6600	2200 (J ₂)
Chloroform	ND	ND	ND	ND	10 (J ₅)
1,1-Dichloroethane	ND	ND	ND	ND	ND
1,2-Dichloroethene (total)	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND
Methylene chloride	ND	1.4 (J ₅)	1300	88000	600
Tetrachloroethene (PCE)	5800	3.4 (J ₆)	ND	8500 (J ₄)	19 (J ₆)
Toluene	ND	ND	16 (J ₅)	1700 (J ₅)	130
1,1,1-Trichloroethane	1200	ND	ND	6300	ND
Trichloroethene (TCE)	ND	ND	ND	ND	ND
Xylene	350 (J ₅)	ND	ND	ND	34 (J ₅)
Semivolatile organic compounds ($\mu\text{g/L}$):					
Benzoic acid	ND	2.8 (J ₆)†	ND	ND	ND
Benzyl alcohol	340 (J ₆)	48 (J ₃)	ND	1100000 (J ₃)	ND
di-n-Butyl phthalate	ND	2.1 (J ₆)†	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND
bis (2-Ethylhexyl) phthalate	ND	3.3 (J ₆)	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	29
Fluorene	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND
2-Methylphenol (o-cresol)	ND	ND	ND	ND	ND
4-Methylphenol (p-cresol)	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND
di-n-Octyl phthalate	ND	ND	ND	ND	ND
Phenol	30000 (J ₆)	27 (J ₆)	4500 (J ₆)	480000 (J ₆)	3400 (J ₆)
Pyrene	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	410 (J ₆)	ND	ND	ND	39
Total purgeable hydrocarbons ($\mu\text{g/L}$):					
Gasoline	9960	ND	99.5	5880	1080

Table 4.2 continued

Chemical	Sample Identification			
	IWTBG2280	IWTBG2211	IWTBG2127	IWTLS6OLD
Total extractable hydrocarbons (µg/L):				
Diesel C10-C22	ND	ND	ND	ND
Kerosene C9-C18	ND	ND	ND	ND
Miscellaneous C7	NA	NA	NA	NA
Miscellaneous C7-C24	54200 (J4)	NA	5430	10100
Miscellaneous C12-C24	ND	4890	NA	NA
NA				
Metals (µg/L):54200				
Barium	9090 (J4)	363 (J4)	61.3 (J4)	1640 (J4)
Cadmium	124 (J4)	ND	ND	21.4 (J4)
Chromium	8800	67.5	334	1700
Lead	25.7 (J4)	ND	5.4 (J4)	50 (J4)
Mercury	ND	ND	ND	67.9 (J4)
Nickel	10.8 (J4)	279 (J4)	ND	ND
Selenium	ND	ND	ND	ND
Silver	ND	ND	ND	ND
Zinc	6520 (J4)	29.8 (J4)	94.8 (J4)	1150 (J4)

NA = not applicable

ND = not detected

1 IWTLS2D is a duplicate of IWTLS2.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J1 Blank contamination. Indicates possible high bias and/or false positives.

J2 Calibration range exceeded. Indicates possible low bias.

J3 Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J4 Other QC criteria outside control limits. Bias not readily determined.

J5 Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J6 Data is qualified with two or more of the above qualifiers.

Barium was detected in all samples at concentrations ranging from 61.3 $\mu\text{g/L}$ to 9,090 $\mu\text{g/L}$. Chromium was also detected in every sample at concentrations ranging from 15 $\mu\text{g/L}$ to 8,800 $\mu\text{g/L}$. The sample with the highest barium and chromium concentrations was collected from the building 2280 lift station. The lift station 2 sample contained elevated concentrations of lead and nickel, at 2,690 $\mu\text{g/L}$ and 1,810 $\mu\text{g/L}$, respectively.

4.2 STREAM SEDIMENT SAMPLING RESULTS

East Soldier Creek (ESC). Three sediment sampling rounds, in October and November 1993, were performed at East Soldier Creek. Seven samples and one duplicate were collected during each round. The first and second sampling rounds were conducted approximately 30 days apart. PCB samples were collected separately in the third round of sampling. Figure 4.1 shows the sediment sampling locations. Tables 4.3 and 4.4 present the analytical data for VOCs, SVOCs, cyanides, and metals collected in October and November 1993, respectively. Table 4.4 also lists the PCB results from the November sediment sampling.

In general, the concentrations of VOCs were higher in November than in October. Sample SE3D (duplicate) had the highest total concentration of VOCs in October. SE3 had the highest concentration of VOCs in November. Acetone was found in all eight samples in both the first and second sampling round. Chlorobenzene was found in three samples in October and four samples in November. MEK was found in two samples in October and in three samples in November. Methylene chloride was detected in only one October sample, but in three of the November samples. Toluene was detected in only one sample in October, but in four samples in November. PCE was not detected in October, but was found in three samples in November. TCE was detected in one sample in October, but was not found in November. Overall, twice as many VOCs were detected at least once in the November samples as in the October samples.

The methylene chloride, acetone, and phthalates detected are common laboratory contaminants, but methylene chloride and acetone are both components of the IWTP wastewater influent, as shown in Tables 4.1 and 4.2.

In most cases, the concentrations of SVOCs reported in November were higher than those reported in October. SE2 generally had the highest total concentration of all SVOCs detected in October. In November, SE1 showed the highest total concentrations of all SVOCs detected. Though contamination was more often detected in November, the samples from SE6 generally showed the lowest concentrations of all SVOCs reported. In both October and November, the concentration of SVOCs detected in SE4E generally were higher than in SE4W.

Ten metals were detected in the stream sediment samples. In most cases, concentrations for samples collected in October were similar to those collected in November. The highest concentrations of metals generally were detected in sample SE2, while the lowest or nondetectable concentrations of metals generally were found in sample SE4W. Cadmium and chromium were detected in all samples. Barium, mercury, silver, and zinc were detected in all of the samples at least once.

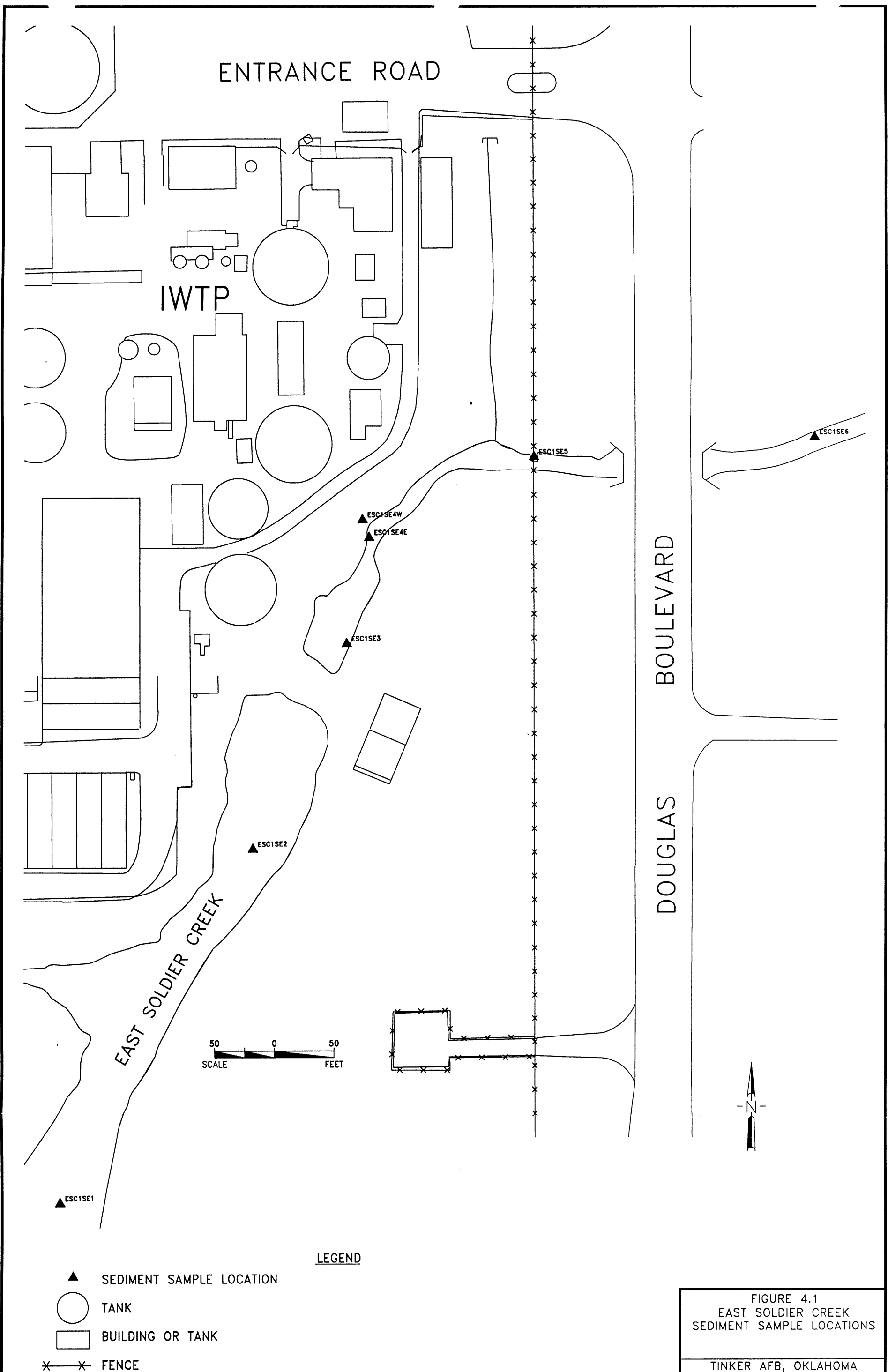


FIGURE 4.1
EAST SOLDIER CREEK
SEDIMENT SAMPLE LOCATIONS

TINKER AFB, OKLAHOMA

Table 4.3 Chemical Constituents Detected in Sediments, October 1993
East Soldier Creek
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth							
	ESCSE1	ESCSE2	ESCSE3	ESCSE3D ¹	ESCSE4E ²	ESCSE4W ³	ESCSE5	ESCSE6
Volatile organic compounds (µg/kg):								
Acetone	32	100	290	310 (J ₂)	23	28	21	38
2-Butanone (MEK)	ND	ND	2.2 (J ₅)†	3 (J ₅)†	ND	ND	ND	ND
Chlorobenzene	ND	62	ND	3.9 (J ₅)	54	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	1.4 (J ₅)†	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	2.3 (J ₁)	ND	ND
Trichloroethene (TCE)	ND	ND	ND	ND	ND	ND	ND	2.3 (J ₅)
Semivolatile organic compounds (µg/kg):								
Acenaphthene	262 (J ₅)	592 (J ₅)	ND	ND	ND	ND	ND	ND
Anthracene	782 (J ₅)	1710	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	4050 (J ₄)	7260 (J ₄)	192 (J ₄)	389 (J ₄)	ND	ND	70.9 (J ₄)	ND
Benzo(a)pyrene	3220	4640	247 (J ₅)	314 (J ₅)	ND	ND	78.6 (J ₅)	ND
Benzo(b)fluoranthene	4390	7810	344 (J ₅)	504 (J ₅)	ND	118 (J ₅)†	167 (J ₅)	ND
Benzo(g,h,i)perylene	2020	192 (J ₅)	195 (J ₅)	297 (J ₅)	ND	ND	ND	ND
Benzo(k)fluoranthene	2960	2970	269 (J ₅)	ND	105 (J ₅)†	ND	ND	ND
Benzoic acid	97.4 (J ₅)	229 (J ₅)	ND	ND	ND	ND	ND	ND
Chrysene	5500 (J ₄)	7830 (J ₄)	349 (J ₄)	616 (J ₄)	ND	ND	127 (J ₄)	ND
Dibenz(a,h)anthracene	719 (J ₅)	616 (J ₅)	ND	ND	ND	ND	ND	ND
Dibenzofuran	140 (J ₅)	382 (J ₅)	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	269 (J ₅)	ND	ND	ND
bis(2-Ethylhexyl)phthalate	3290 (J ₁)	5300 (J ₁)	15300 (J ₁)	11500 (J ₁)	846 (J ₁)	91 (J ₁)	2200 (J ₁)	574 (J ₁)
Fluoranthene	7020	13400	965 (J ₅)	1420	214 (J ₅)	184 (J ₅)	354 (J ₅)	129 (J ₅)
Fluorene	270 (J ₅)	712 (J ₅)	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	1950	678 (J ₅)	204 (J ₅)	274 (J ₅)	ND	ND	ND	ND
2-Methylnaphthalene	ND	133 (J ₅)	ND	ND	ND	ND	ND	ND
Naphthalene	143 (J ₅)	324 (J ₅)	ND	ND	ND	ND	ND	ND
di-n-Octylphthalate	ND	589 (J ₅)	1540	1310	1010	ND	253 (J ₅)	ND
Phenanthrene	3940	9240	249 (J ₅)	371 (J ₅)	ND	ND	125 (J ₅)	ND
Pyrene	6380	12500	956 (J ₅)	878 (J ₅)	83.1 (J ₅)†	117 (J ₅)	164 (J ₅)	ND

Table 4.3, cont.

Chemical	Sample Identification and Depth					
	ESCSE1	ESCSE2	ESCSE3	ESCSE3D ¹	ESCSE4E ²	ESCSE4W ³
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND
Metals (mg/kg):						
Arsenic	ND	5.91	ND	ND	ND	ND
Barium	268 (J ₆)	559 (J ₆)	478 (J ₆)	384 (J ₆)	158 (J ₆)	598 (J ₆)
Cadmium	3.54	44.7	14.2	10	3.73	2.58
Chromium, total	59.8	260	382	270	68.1	29.7
Lead	37.9	112	42.5	35.9	37.8	14.7
Mercury	0.2	0.35	0.25	0.21	ND	ND
Nickel	26.8 (J ₄)	74.8 (J ₄)	61.7 (J ₄)	49.4 (J ₄)	12.1 (J ₄)	12.2 (J ₄)
Selenium	ND	ND	1.32	1.06	0.58	ND
Silver	1.77	3.94	2.48	2.13	0.82	ND
Zinc	89 (J ₄)	374 (J ₄)	124 (J ₄)	92.1 (J ₄)	12 (J ₄)	41.4 (J ₄)

ND = not detected

NA = not applicable

¹ ESCSE3D is a replicate of ESC1SE3.

² ESCSE4E was collected from the east side of the stream at location SE4.

³ ESCSE4W was collected from the west side of the stream at location SE4.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.4 Chemical Constituents Detected in Sediments, November 1993
East Soldier Creek
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth							
	ESCSE1	ESCSE2	ESCSE3	ESCSE4E1	ESCSE4W2	ESCSE5	ESCSE5D3	ESCSE6
Volatile organic compounds ($\mu\text{g/kg}$):								
Acetone	210 (J4)	160 (J4)	3000 (J4)	1100 (J4)	59 (J4)	93 (J4)	64 (J4)	15 (J4)
2-Butanone (MEK)	25 (J4)	27 (J4)	ND	2100 (J4)	ND	ND	ND	ND
Chlorobenzene	30 (J6)	110 (J6)	1600 (J6)	6700 (J6)	ND	ND	ND	ND
Chloroform	ND	ND	190 (J6)	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	1300 (J6)	ND	ND	ND	ND	ND
Methylene chloride	13 (J4)	18 (J4)	ND	ND	ND	ND	22 (J4)	ND
Styrene	ND	ND	ND	ND	ND	31 (J4)	ND	ND
Tetrachlorethene (PCE)	ND	ND	ND	ND	ND	62 (J4)	42 (J4)	6.8 (J4)
Toluene	ND	ND	11000 (J6)	410 (J6)	ND	48 (J4)	25 (J4)	ND
Trichloroethene (TCE)	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (total)	ND	ND	5400 (J4)	ND	ND	ND	ND	ND
Semivolatile organic compounds ($\mu\text{g/kg}$):								
Acenaphthene	891 (J4)	359 (J6)	ND	ND	ND	ND	ND	39.1 (J6)
Anthracene	2180 (J4)	881 (J4)	ND	ND	ND	ND	ND	51.4 (J6)
Benzo(a)anthracene	5480 (J6)	3020 (J6)	176 (J6)	79.1 (J6)	72.2 (J6)	204 (J6)	477 (J6)	438 (J6)
Benzo(a)pyrene	5390 (J6)	3250 (J6)	156 (J6)	48.1 (J6)	71.6 (J6)	238 (J6)	639 (J6)	577 (J6)
Benzo(b)fluoranthene	6900 (J6)	4990 (J6)	240 (J6)	72 (J6)†	70 (J6)†	276 (J6)	1030 (J6)	705 (J6)
Benzo(g,h,i)perylene	3620 (J6)	1940 (J6)	127 (J6)	51.8 (J6)†	ND	174 (J6)	292 (J6)	457 (J6)
Benzo(k)fluoranthene	5150 (J6)	4240 (J6)	181 (J6)	77.9 (J6)†	73.3 (J6)†	269 (J6)	1170 (J6)	536 (J6)
Benzoic acid	ND	ND	ND	ND	ND	2400 (J6)	ND	ND
Butyl benzyl phthalate	ND	ND	ND	310 (J6)	ND	ND	ND	ND
di-n-Butylphthalate	55.4 (J6)	89.9 (J6)	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	364 (J6)	552 (J6)	385 (J6)	ND	290 (J6)	385 (J6)	293 (J6)	315 (J6)
2-Chlorophenol	378 (J6)	528 (J6)	425 (J6)	357 (J6)	509 (J6)	428 (J6)	407 (J6)	334 (J6)
Chrysene	6970 (J6)	4540 (J6)	298 (J6)	145 (J6)	88.5 (J6)	328 (J6)	818 (J6)	587 (J6)
Dibenz(a,h)anthracene	1530 (J6)	1220 (J6)	ND	ND	ND	77.6 (J6)	171 (J6)	232 (J6)
Dibenzofuran	412 (J6)	188 (J6)	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	287 (J6)	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	61.4 (J6)	2390 (J4)	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ND	6020 (J6)	7530	103000	100 (J6)	3500 (J6)	6300 (J6)	1090 (J6)
Fluoranthene	18100	4160 (J4)	529 (J4)	1900 (J4)	178 (J6)	1110 (J4)	1060 (J4)	754 (J4)
Fluorene	901 (J4)	387 (J6)	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	3250 (J6)	2120 (J6)	118	ND	ND	155 (J6)	312 (J6)	395 (J6)
2-Methylnaphthalene	85.6 (J6)	ND	ND	ND	ND	ND	ND	ND

Table 4.4, cont.

Chemical	Sample Identification and Depth							
	ESCSE1	ESCSE2	ESCSE3	ESCSE4E1	ESCSE4W2	ESCSE5	ESCSE5D3	ESCSE6
4-Methylphenol (p-cresol)	ND	ND	ND	ND	ND	217 (J6)	409 (J6)	ND
Naphthalene	521 (J4)	216 (J6)	ND	94.1 (J6)	ND	ND	ND	ND
4-Nitrophenol	390 (J6)	625 (J6)	626 (J6)	ND	266 (J6)	329 (J6)	407 (J6)	384 (J6)
di-n-Octylphthalate	273 (J6)	ND	607 (J4)	12100	ND	841 (J4)	1010 (J4)	89.4 (J6)
Pentachlorophenol	333 (J6)	484 (J6)	327 (J6)	ND	319 (J6)	394 (J6)	363 (J6)	219 (J6)
Phenanthrene	12000	4930 (J6)	134 (J6)	489 (J6)	ND	349 (J6)	206 (J6)	180 (J6)
Phenol	470 (J6)	642 (J6)	551 (J6)	454 (J6)	419 (J6)	742 (J6)	875 (J6)	531 (J6)
Pyrene	14500	7620	619 (J6)	269 (J6)	142 (J6)	544 (J4)	671 (J4)	848 (J4)
Cyanide (mg/kg)	ND	ND	1.39	4.12	ND	1.5	1.66	0.65
PCB (µg/kg):								
Arochlor 1254	464	ND	41 (J4)	ND	ND	ND	ND	ND
Metals (mg/kg):								
Arsenic	3.7	5.41	1.44	ND	3.54	ND	ND	1.51
Barium	440	610	293	611	560	390	368	161
Cadmium	8.13 (J4)	33.7 (J4)	18.2 (J4)	8.38 (J4)	2.83 (J4)	26.9 (J4)	22.7 (J4)	3.83 (J4)
Chromium, total	161 (R)	214 (R)	464 (R)	371 (R)	42.9 (R)	289 (R)	225 (R)	40.5 (R)
Lead	81.3	106	53.2	25.3	11.9	36.9	34.6	32.2
Mercury	0.27	0.42	0.21	0.60	0.45	0.23	0.17	ND
Nickel	58.7	78.9	90	69	15.1	51.1	46.4	14.3
Selenium	2.07	ND	1.59	ND	ND	ND	ND	ND
Silver	5.17	5	4.48	3.57	0.42	3.93	3.6	0.70
Zinc	197	298	106	35.6	37.8	66.2	104	15.4

ND = not detected

NA = not applicable

1 ESCSE4E was collected from the east side of the stream at location SE4.

2 ESCSE4W was collected from the west side of the stream at location SE4.

3 ESCSE5D is a replicate of ESC1SE5.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and maximum quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

The R data qualifier indicates that the data are unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified.

Selenium was detected in both rounds at SE3. Arsenic was detected more often in November than in October. There is no uniform increase or decrease in concentrations of metals in the samples moving downstream.

Cyanides were not detected in October samples, but were detected in five of the November samples. The highest concentration occurred at SE4E. Though not analyzed in the first or second rounds, PCBs were detected in the third-round samples collected at locations SE1 and SE3. The maximum PCB concentration was 464 $\mu\text{g/kg}$ of Aroclor 1254 at SE1.

4.3 SWMU SOIL GAS AND SOIL SAMPLE RESULTS

The following sections detail the results of the soil gas and soil sampling performed at the WWTF. Figures 4.2, 4.3, and 4.4 show the sampling locations for soil gas, surface soil, and soil borings, respectively. The sampling results are presented separately for each SWMU.

4.3.1 Lift Station 2 (SWMU 24.1)

At this SWMU, seven soil gas samples were collected, and one soil boring was drilled. Two soil boring samples were collected.

Soil Gas. Most of the target compounds were detected in the soil gas at this SWMU, as shown in Table 4.5. Concentrations of 1,1,1-trichloroethane (TCA)/1,2-dichloroethene (DCE), 1,2-DCA, TCE, toluene, PCE, and o-xylene were all below 1 ppmv. Ethylbenzene was not detected with the exception of SG13 (3 ppmv). Vinyl chloride and 1,1-DCE had concentrations greater than 1 ppmv. Maximum concentrations included 17 ppmv vinyl chloride in SG2 and 6 ppmv 1,1-DCE in SG1. The north and east sides of SWMU 24.1 appear to have the highest overall concentrations of VOCs in the soil gas.

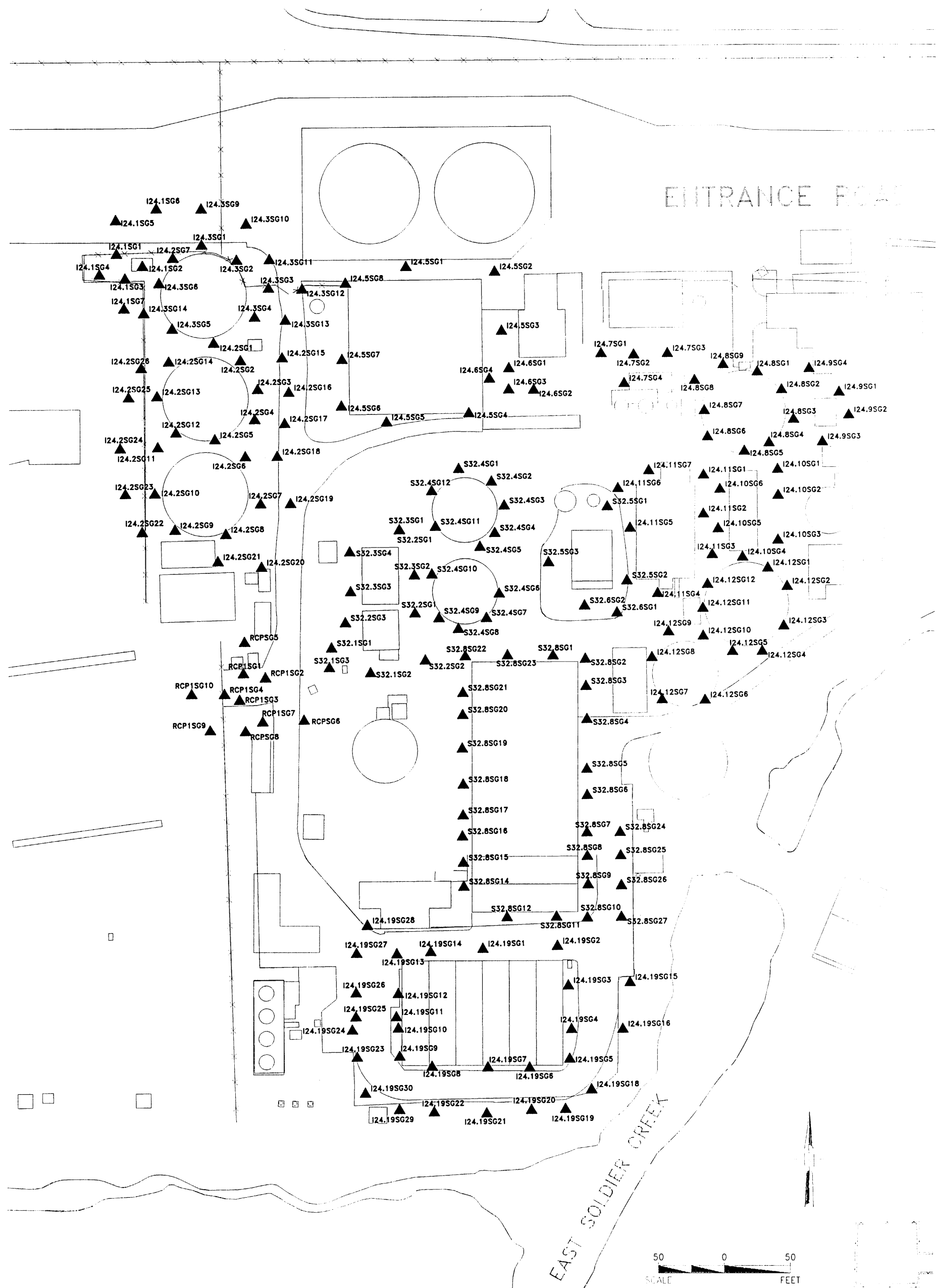
Soil Borings. Only one soil boring (SB1) was drilled at this location. Two soil samples were collected from SB1 for chemical analysis, one from 5.5 to 6.5 feet bgs, and one from 16.0 to 16.5 feet bgs. The results are presented in Table 4.6. In both of these samples, methylene chloride was detected at a concentration of 22 $\mu\text{g/kg}$, and bis(2-ethylhexyl)phthalate was detected at concentrations of 111 $\mu\text{g/kg}$ (5.5-6.5') and 90.1 $\mu\text{g/kg}$ (16.0-16.5').

The concentration of arsenic was slightly above the low end of the concentration range (2-11 mg/kg) in SB1 (16.0-16.5'), where it was found at 2.43 mg/kg. Also in SB1 (16.0-16.5'), the concentration of barium was 4,710 mg/kg. This value is well above the concentration range for barium (47-570 mg/kg).

4.3.2 Tanks D-1 and D-2 (SWMU 24.2)

Twenty-six soil gas samples and four surface soil samples were collected at this SWMU. Eight soil borings were planned for this unit; however, only seven were drilled because of utility constraints. A total of fifteen soil boring samples were collected.

Soil Gas. All target compounds were detected in soil gas samples collected at this SWMU (Table 4.7). Maximum concentrations included 56 ppmv vinyl chloride

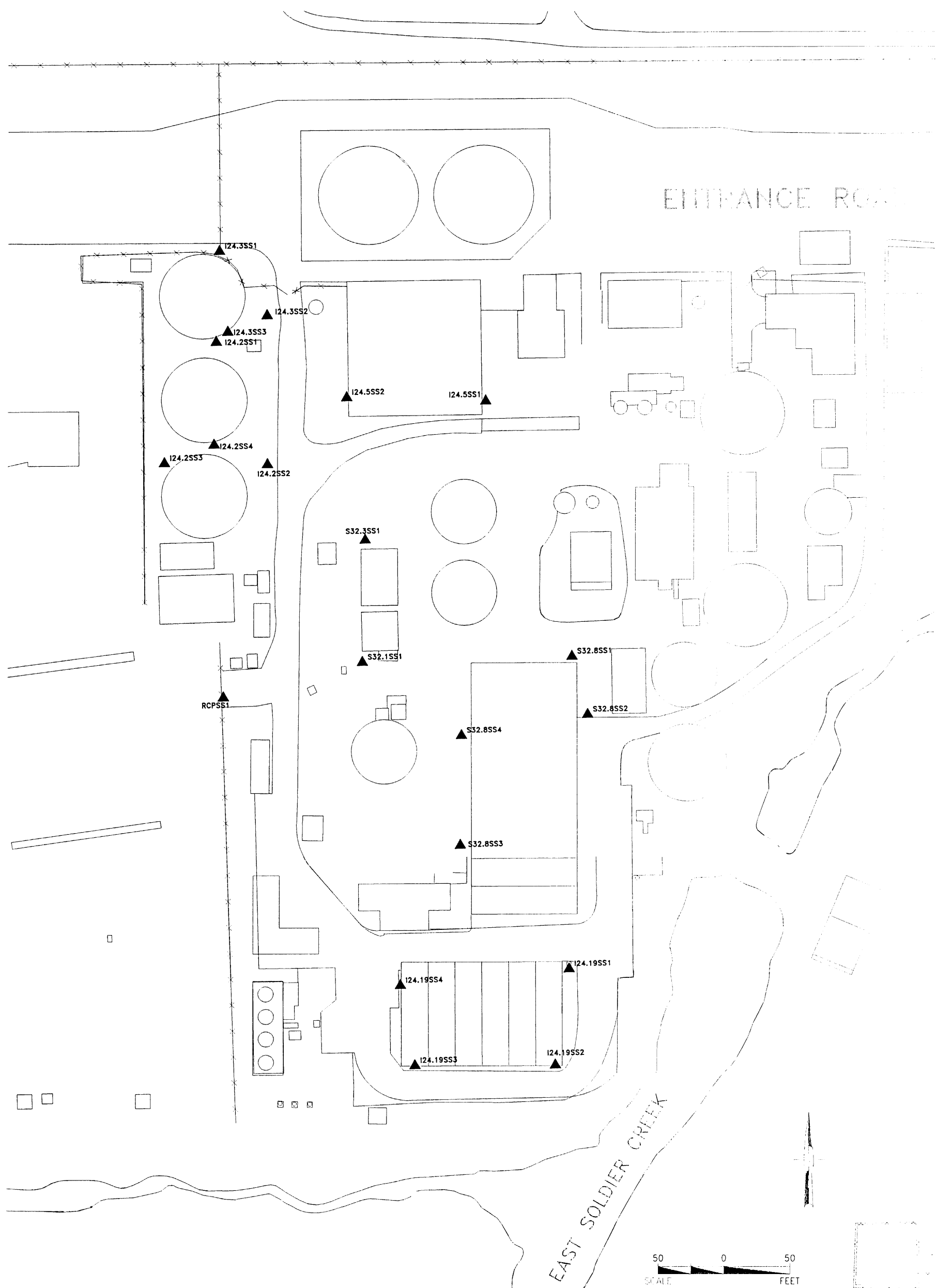


- ▲ SOIL GAS SAMPLING LOCATION
- TANK
- BUILDING OR TANK
- ✕—✕ FENCE

LEGEND

FIGURE 4.2
SOIL GAS SAMPLE
LOCATIONS MAP

TINKER AFB, OKLAHOMA

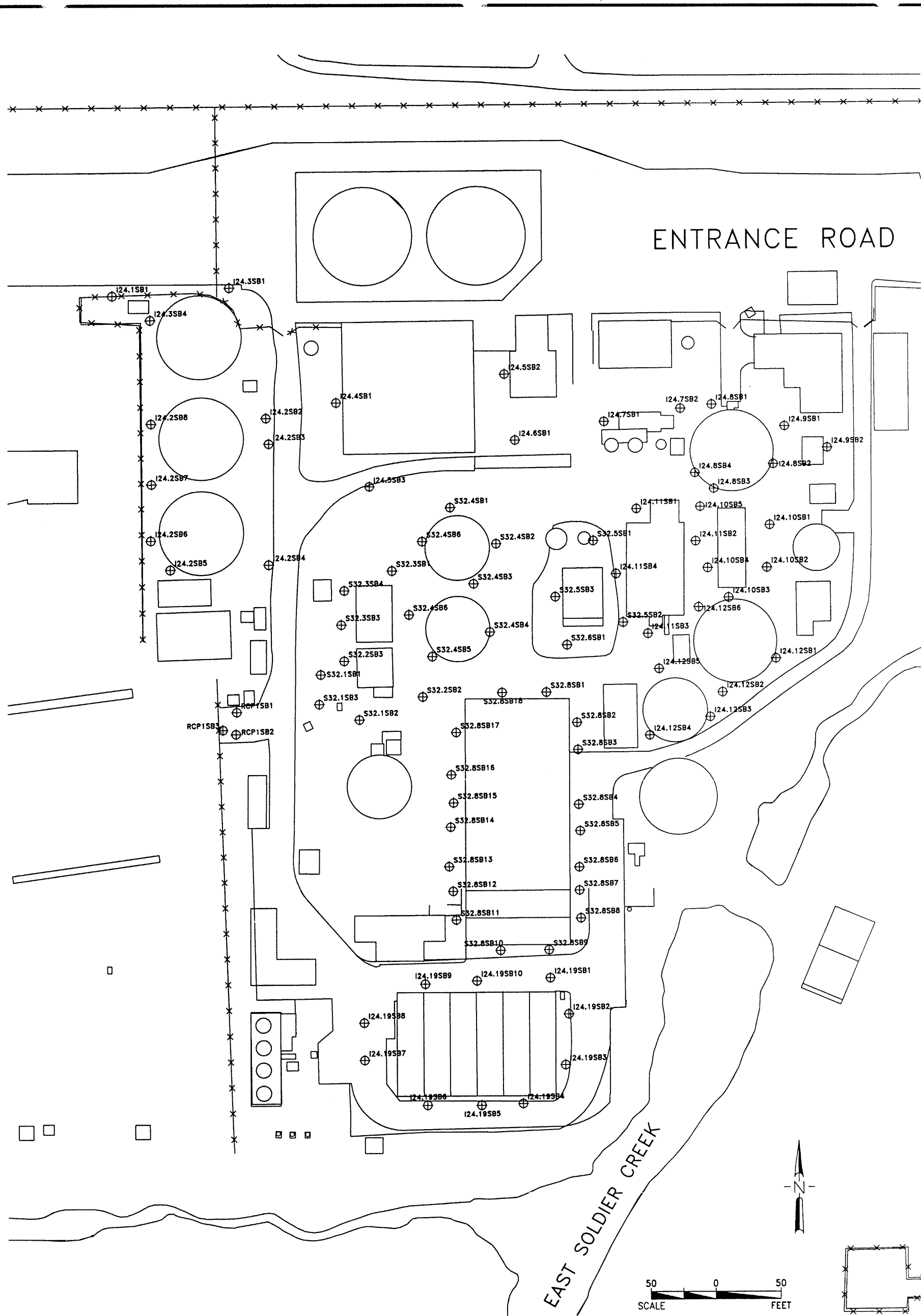


LEGEND

- ▲ SURFACE SOIL SAMPLE LOCATION
- TANK
- BUILDING OR TANK
- ×—× FENCE

FIGURE 4.3
SURFACE SOIL
SAMPLE
LOCATIONS

TINKER AFB, OKLAHOMA



- ⊕ SOIL BORING LOCATION
- TANK
- BUILDING OR TANK
- × FENCE

LEGEND

FIGURE 4.4
SOIL BORING
LOCATIONS MAP

TINKER AFB, OKLAHOMA

Table 4.5
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.1, Lift Station
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
IWT24.1 SG1	<1	6	<1	<1	<1	0.3 J	0.2 J	0.1 J	0.1 J	3	<1	1
IWT24.1 SG66*	1	2	<1	0.4 J	<1	0.3 J	0.2 J	0.1 J	0.2 J	<1	<1	1.5
IWT24.1 SG3	2	5	<1	0.3 J	<1	<1	0.2 J	0.1 J	<1	<1	<1	6
IWT24.1 SG5	<1	0.4 J	<1	0.2 J	<1	0.1 J	0.1 J	0.1 J	0.1 J	<1	0.1 J	3
IWT24.1 SG6	<1	0.7 J	<1	<1	<1	<1	0.1 J	<1	<1	<1	<1	1
IWT24.1 SG7	0.8 J	0.1 J	<1	0.2 J	<1	<1	<1	<1	0.2 J	<1	0.1 J	3

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J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane ppmv = parts per million vapor
DCE = dichloroethene TCA = trichloroethane
PCE = tetrachloroethene TCE = trichloroethene

Note: IWT24.1 SG4 was not collected.

Table 4.6 Chemical Constituents Detected in Soils, November 1993
SWMU 24.1, Lift Station
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth		Background Range ¹
	I24.1SB1 5.5-6.5 ft.	I24.1SB1 16.0-16.5 ft.	
Volatile organic compounds (µg/kg):			
Methylene chloride	22	22	NA
Semivolatile organic compounds (µg/kg):			
bis(2-Ethylhexyl)phthalate	111 (J ₅)	90.1 (J ₅)†	NA
Cyanide (mg/kg)	ND	ND	NA
Metals (mg/kg):			
Arsenic	0.98	2.43	2-11
Barium	41.1	4,710	47-570
Chromium, total	4.45	4.16	6-74
Lead	1.41	.809	<4-45
Nickel	2.49	5.08	6-32
Zinc	4.23	7.16	5-53

SWMU = Solid Waste Management unit

ND = not detected

NA = not analyzed or not applicable

¹ Average background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.7
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.2, Tanks D-1 and D-2
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
IWT 24.2 SG1	5	3	<1	2	<1	<1	<1	<1	2	<1	<1	0.4 J
IWT 24.2 SG2	4	4	<1	1 J	<1	<1	<1	<1	0.2 J	<1	<1	0.2 J
IWT 24.2 SG3	35	0.3 J	<1	3	<1	<1	<1	<1	0.8 J	<1	<1	2
IWT 24.2 SG4	4	1	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	2
IWT 24.2 SG5	<1	4	27	4	<1	1	0.3 J	<1	0.7 J	<1	<1	3
IWT 24.2 SG6	27	4	10	<1	<1	0.7 J	0.2 J	<1	12	<1	<1	3
IWT 24.2 SG7	9	9	3	4	<1	1	0.2 J	<1	7	<1	<1	3
IWT 24.2 SG8	56	2	<1	3	<1	2	0.3 J	<1	12	<1	<1	6
IWT 24.2 SG9	<1	0.5 J	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	0.2 J
IWT 24.2 SG10	4	3	<1	20	<1	6	0.2 J	0.1 J	0.6 J	0.4 J	<1	31
IWT 24.2 SG11	<1	<1	0.5 J	2	<1	<1	<1	<1	<1	<1	<1	NA
IWT 24.2 SG12	3	<1	0.5 J	2	<1	<1	<1	<1	<1	<1	<1	9
IWT 24.2 SG13	<1	3	<1	1	<1	<1	0.1 J	0.1 J	0.1	<1	<1	0.8 J
IWT 24.2 SG14	0.4 J	0.8 J	9	1	<1	0.9 J	2	0.2 J	0.1	<1	<1	20
IWT 24.2 SG15	<1	2	<1	<1	<1	<1	0.1 J	0.1 J	0.1 J	<1	<1	3
IWT 24.2 SG16	0.9 J	4	<1	0.7 J	<1	<1	0.1 J	0.1 J	0.1 J	<1	<1	0.8 J
IWT 24.2 SG17	0.8 J	6	<1	0.9 J	<1	0.5 J	0.2 J	0.6 J	<1	<1	<1	4
IWT 24.2 SG18	<1	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	3
IWT 24.2 SG19	26	10	<1	0.3 J	<1	<1	0.2 J	2	5	3	2	240
IWT 24.2 SG20	<1	1	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	0.5 J
IWT 24.2 SG21	<1	2	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	2
IWT 24.2 SG22	<1	3	<1	0.5 J	0.1 J	0.5 J	0.3 J	0.4 J	<1	<1	<1	3
IWT 24.2 SG23	2	0.4 J	<1	<1	<1	<1	0.1 J	0.2 J	0.1 J	<1	<1	1
IWT 24.2 SG24	<1	2	<1	<1	<1	<1	<1	0.1 J	<1	<1	<1	3
IWT 24.2 SG25	15	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	5
IWT 24.2 SG26	1	1	<1	0.3 J	<1	<1	<1	<1	0.1 J	<1	<1	4
IWT 24.2 SG27	5	<1	<1	3	<1	<1	<1	<1	<1	<1	<1	2
IWT 24.2 SG28	<1	0.9 J	<1	8	<1	<1	<1	<1	<1	<1	<1	6
IWT 24.2 SG29	23	70	<1	4	<1	<1	<1	0.3 J	0.2 J	<1	<1	5
IWT 24.2 SG30	3	0.1 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	1

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane ppmv = parts per million vapor
DCE = dichloroethene TCA = trichloroethane
NA = not available TCE = trichloroethene
PCE = tetrachloroethene

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(SG63), 70 ppmv 1,1-DCE (SG25), 27 ppmv 1,1-DCA (SG5), 20 ppmv 1,1,1-TCA/1,2-DCE in SG9, as well as 6 ppmv 1,1,1-TCA/1,2-DCE, 6 ppmv 1,2-DCA, and 12 ppmv PCE in SG9. Twelve ppmv PCE was also detected in SG63. Ethylbenzene and o-xylene were detected at or below 3 ppmv in SG17.

Surface Soils. Analytical results of the four surface soil samples and one duplicate taken at this SWMU are presented in Table 4.8. The sample collected from SS2 had the highest overall concentration of total VOCs (82.8 $\mu\text{g/kg}$), and SS1 had the lowest (5.8 $\mu\text{g/kg}$). Methylene chloride and PCE were detected in four out of five samples. Acetone and chloroform were detected in three out of five samples.

The highest overall concentration of total SVOCs (10,841 $\mu\text{g/kg}$) was found in SS2. The second highest total concentration was found in SS3 (2,525 $\mu\text{g/kg}$), and the lowest total concentration was 1,419.3 $\mu\text{g/kg}$ in sample SS1. Cyanide was detected at three of the four surface soil locations. No PCBs were detected.

Arsenic was detected in two samples (SS3 and SS4), both within the USGS concentration range. Cadmium was detected in all soil borings above the detection level of the comparison survey (2 mg/kg). The maximum cadmium concentration in the surface soil samples was found in SS1 (49.2 mg/kg). All surface soil samples contained chromium and nickel above their respective concentration ranges (6-74 and 3-32 mg/kg). Nickel concentrations were particularly high in SS1 at 1510 mg/kg. The concentration of lead in SS1 was also above the concentration range.

Soil Borings. A total of seven soil borings (SB2 through SB8) were sampled at this unit. Table 4.8 shows the results of the sample analysis. Acetone and methylene chloride were detected in all soil borings except SB4 at concentrations ranging from 7.7 to 2,900 $\mu\text{g/kg}$ and 1.2 to 7.7 $\mu\text{g/kg}$, respectively. Compared to other soil borings, the concentration of acetone was very high in SB6 (5.5-6.5'), where it was found at 2,900 $\mu\text{g/kg}$. Also in SB6 (5.5-6.5'), the concentrations of methyl ethyl ketone (2-butanone) and toluene were relatively high: 3,400 $\mu\text{g/kg}$ and 810 $\mu\text{g/kg}$, respectively. Methyl ethyl ketone was also found in SB3, SB5, and SB8 at concentrations ranging from 3.3 to 18.0 $\mu\text{g/kg}$. Toluene was found in SB5, SB6 (17.0-18.0'), SB7, and SB8 at concentrations ranging from 1.2 to 5.5 $\mu\text{g/kg}$, respectively. PCE was detected in SB5 (5.0-6.0') and SB8 (5.0-6.0') at concentrations of 2.9 $\mu\text{g/kg}$ and 1.3 $\mu\text{g/kg}$, respectively.

Sixteen SVOCs were detected in soil borings at this location. Benzo(a)pyrene and pyrene were detected in SB4 (8.5-9.5') at estimated concentrations of 40 $\mu\text{g/kg}$ and 69 $\mu\text{g/kg}$, respectively. The concentration of pyrene was below the MDL. Pyrene was also detected in SB5 (5.0-6.0') at a concentration of 102 $\mu\text{g/kg}$. Bis(2-ethylhexyl)phthalate was detected below the MDL (90.1 $\mu\text{g/kg}$) in SB3, SB4, SB7, and SB8 at concentrations ranging from 36 to 79 $\mu\text{g/kg}$. Phenol was detected in all soil borings except SB4. In SB2, 5, 6, 7, and 8, phenol was detected at concentrations ranging from 207 to 460 $\mu\text{g/kg}$. In SB3 (6.0-7.0') phenol was detected at a relatively high concentration of 1,400 $\mu\text{g/kg}$. Several other varieties of phenol, including 2-chlorophenol, 2,4-dimethylphenol, 2-methylphenol (o-cresol), 4-methylphenol (p-cresol), pentachlorophenol, 4-chloro-3-methylphenol, and 4-nitrophenol were present in certain soil borings at concentrations ranging from 144

Table 4.8 Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.2, Tanks D-1 and D-2
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth							Background Range ²
	I24.2SS1* 0.17-0.25 ft.	I24.2SS2* 0.17-0.5 ft.	I24.2SS2D1* 0.17-0.5 ft.	I24.2SS3* 0.33-0.5 ft.	I24.2SS4* 0.17-0.33 ft.	I24.2SB2 8.0-8.5 ft.	I24.2SB2 17.0-18.0 ft.	
Volatile organic compounds (µg/kg):								
Acetone	ND	63 (J ₄)	30 (J ₄)	ND	13 (J ₄)	1100 (J ₆)	60 (J ₄)	NA
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	NA
Chloroform	ND	2 (J ₁)	ND	2 (J ₁)	1.9 (J ₁)	ND	ND	NA
Methylene chloride	ND	16 (J ₄)	1.6 (J ₄)	12 (J ₄)	10 (J ₄)	80 (J ₄)	ND	NA
Tetrachloroethene (PCE)	5.8	1.8 (J ₃)	1.1 (J ₅)†	9.2	ND	ND	ND	NA
Toluene	ND	ND	ND	ND	ND	ND	ND	NA
Semivolatile organic compounds (µg/kg):								
Benzo(a)anthracene	ND	ND	ND	204 (J ₅)	141 (J ₅)	ND	ND	NA
Benzo(a)pyrene	ND	ND	ND	182 (J ₅)	117 (J ₅)	ND	ND	NA
Benzo(b)fluoranthene	ND	ND	ND	172 (J ₅)	89.4 (J ₅)	ND	ND	NA
Benzo(g,h,i)perylene	ND	ND	ND	142 (J ₅)	ND	ND	ND	NA
Benzo(k)fluoranthene	ND	ND	ND	162 (J ₅)	132 (J ₅)	ND	ND	NA
Benzoic acid	ND	169 (J ₅)	150 (J ₅)	ND	ND	ND	ND	NA
di-n-Butylphthalate	70.4 (J ₅)	ND	ND	ND	ND	ND	ND	NA
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	407 (J ₆)	225 (J ₆)	NA
2-Chlorophenol	ND	ND	ND	237 (J ₅)	151 (J ₅)	ND	248 (J ₆)	NA
Chrysene	ND	ND	ND	ND	ND	ND	ND	NA
1,2-Dichlorobenzene	144 (J ₅)	ND	ND	ND	ND	ND	ND	NA
Diethylphthalate	71.8 (J ₅)	ND	ND	ND	ND	128 (J ₆)	ND	NA
2,4-Dimethylphenol	96.7 (J ₅)	ND	ND	ND	ND	43.3 (J ₆)†	40.6 (J ₆)†	NA
bis(2-Ethylhexyl)phthalate	865 (J ₁)	8850 (J ₁)	6730 (J ₁)	223 (J ₁)	203 (J ₁)	ND	ND	NA
Fluoranthene	98.3 (J ₅)	190 (J ₅)	156 (J ₅)	454 (J ₅)	298 (J ₅)	ND	ND	NA
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	115 (J ₅)	ND	ND	ND	NA
2-Methylphenol (o-Cresol)	ND	ND	ND	ND	ND	1350 (J ₄)	ND	NA
4-Methylphenol (p-Cresol)	ND	152 (J ₅)	247 (J ₅)	ND	ND	1670 (J ₄)	ND	NA
4-Nitrophenol	ND	ND	ND	ND	ND	185 (J ₆)	158 (J ₆)	NA
di-n-Octylphthalate	ND	1320	1060	ND	ND	ND	ND	NA
Pentachlorophenol	ND	ND	ND	ND	ND	153 (J ₆)†	77.3 (J ₆)†	NA
Phenanthrene	73.1 (J ₅)	ND	ND	237 (J ₅)	202 (J ₅)	ND	ND	NA
Phenol	ND	ND	ND	ND	ND	4210 (J ₆)	366 (J ₆)	NA
Pyrene	ND	160 (J ₅)	129 (J ₅)	397 (J ₅)	272 (J ₅)	ND	ND	NA
Cyanide (mg/kg)	5.43 (J ₆)	3.68 (J ₆)	1.86 (J ₆)	ND	0.76 (J ₆)	2.37	ND	NA
PCBs (µg/kg)	ND	ND	ND	ND	ND	NA	NA	NA
Metals (mg/kg):								
Arsenic	ND	ND	ND	4.08	1.63	4.29	4.64	2-11
Barium	317 (J ₆)	171 (J ₆)	257 (J ₆)	250 (J ₆)	208 (J ₆)	421	1270	47-570
Cadmium	49.2 (J ₆)	16.2 (J ₆)	25 (J ₆)	4.08 (J ₆)	31.5 (J ₆)	ND	ND	<2.0
Chromium, total	945 (J ₄)	254 (J ₄)	412 (J ₄)	120 (J ₄)	343 (J ₄)	24 (R)	22 (R)	6-74
Lead	104 (J ₄)	37.4 (J ₄)	43.2 (J ₄)	21 (J ₄)	46.7 (J ₄)	3.5	4.53	<4.48
Mercury	0.98	0.16	0.2	0.11	ND	ND	0.11	NA
Nickel	1510 (J ₄)	370 (J ₄)	549 (J ₄)	39.7 (J ₄)	102 (J ₄)	23.8	21.2	6-32
Selenium	ND	ND	ND	ND	ND	ND	ND	<0.1-2
Silver	26.8 (J ₄)	16.1 (J ₄)	25.7 (J ₄)	5.33 (J ₄)	6.43 (J ₄)	ND	ND	<2
Zinc	93.4 (J ₄)	262 (J ₄)	105 (J ₄)	50.8 (J ₄)	39.7 (J ₄)	20.6	24.5	5-53

Table 4.8 continued

Chemical	Sample Identification and Depth							Background Range ²
	I24.2SS1* 0.17-0.25 ft.	I24.2SS2* 0.17-0.5 ft.	I24.2SS2D1* 0.17-0.5 ft.	I24.2SS3* 0.33-0.5 ft.	I24.2SS4* 0.17-0.33 ft.	I24.2SB2 8.0-8.5 ft.	I24.2SB2 17.0-18.0 ft.	
Volatile organic compounds (µg/kg):								
Acetone	140 (J ₁)	24 (J ₁)	38 (J ₁)	160 (J ₄)	7.7 (J ₄)	2900 (J ₄)	26 (J ₄)	NA
2-Butanone (MEK)	18	ND	ND	12	ND	3400	ND	NA
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	7.4 (J ₁)	5.6 (J ₁)	15	7.7 (J ₄)	4.2 (J ₆)	ND	2.9 (J ₆)	NA
Tetrachloroethene (PCE)	ND	ND	2.7 (J ₅)	2.9 (J ₆)	ND	ND	ND	NA
Toluene	ND	ND	1.4 (J ₅)	4.1 (J ₆)	1.9 (J ₆)	810 (J ₆)	1.2 (J ₆)	NA
Semivolatile organic compounds (µg/kg):								
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	NA
Benzo(a)pyrene	ND	ND	40 (J ₅)	ND	ND	ND	ND	NA
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	NA
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	NA
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	NA
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	NA
4-Chloro-3-methylphenol	ND	ND	ND	488 (J ₁)	290 (J ₁)	352 (J ₁)	302 (J ₁)	NA
2-Chlorophenol	ND	ND	ND	406 (J ₁)	304 (J ₁)	310 (J ₁)	301 (J ₁)	NA
Chrysene	ND	ND	40 (J ₅)	ND	ND	ND	ND	NA
1,2-Dichlorobenzene	94 (J ₅)	ND	ND	ND	ND	ND	ND	NA
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	NA
2,4-Dimethylphenol	210 (J ₅)	ND	ND	ND	ND	ND	ND	NA
bis(2-Ethylhexyl)phthalate	79 (J ₁)†	61 (J ₁)†	52 (J ₁)†	ND	ND	ND	ND	NA
Fluoranthene	ND	ND	100 (J ₅)	ND	ND	ND	ND	NA
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	ND	ND	ND	ND	NA
2-Methylphenol (o-Cresol)	440	ND	ND	ND	ND	ND	ND	NA
4-Methylphenol (p-Cresol)	540	ND	ND	ND	ND	ND	ND	NA
4-Nitrophenol	ND	ND	ND	415 (J ₆)	208 (J ₆)	375	226 (J ₆)	NA
di-n-Octylphthalate	ND	ND	ND	ND	ND	ND	ND	NA
Pentachlorophenol	ND	ND	ND	472 (J ₁)	144 (J ₁)	268 (J ₁)	151 (J ₁)	NA
Phenanthrene	ND	ND	39 (J ₅)†	115 (J ₅)	ND	ND	ND	NA
Phenol	1400	ND	ND	460 (J ₁)	340 (J ₁)	384 (J ₁)	375 (J ₁)	NA
Pyrene	ND	ND	69 (J ₅)†	102 (J ₅)	ND	ND	ND	NA
Cyanide (mg/kg)	ND	ND	ND	0.608	ND	2.16	ND	NA
PCBs (µg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Metals (mg/kg):								
Arsenic	ND	5.57	3.63	ND	4.26	1.7	4.17	2-11
Barium	228	81.2	461 (J ₄)	107 (J ₆)	165 (J ₆)	65.8 (J ₆)	92.8 (J ₄)	47-570
Cadmium	1.71	ND	ND	2.69	ND	ND	ND	<2.0
Chromium, total	106	21.9	22.6 (J ₄)	31 (J ₄)	12.6 (J ₄)	35.4 (J ₄)	12.5 (J ₄)	6-74
Lead	1.59 (J ₄)	8.8 (J ₄)	6.33	1.87	12.9	0.91	9.56	<4.48
Mercury	ND	ND	ND	ND	ND	ND	ND	NA
Nickel	11.7	20.4	24.3	6.43 (J ₄)	23.7 (J ₄)	3.74 (J ₄)	21.4 (J ₄)	6-32
Selenium	ND	ND	0.59	ND	0.77	ND	0.66	<0.1-0.2
Silver	ND	ND	0.12	ND	ND	ND	ND	<2.0
Zinc	13.1	27.7	23.3	4.32 (J ₄)	26.1 (J ₄)	3.29 (J ₄)	25.2 (J ₄)	5-53

Table 4.8 continued

Chemical	Sample Identification and Depth					Background Range
	I24.2SB7 5.5-7.0 ft.	I24.2SD ³ 5.5-7.0 ft.	I24.2SB7 13.5-14.5 ft.	I24.2SB8 5.0-6.0 ft.	I24.2SB8D ⁴ 5.0-6.0 ft.	I24.2SB8 15.5-16.0 ft.
Volatile organic compounds (µg/kg):						
Acetone	70 (J ₄)	75 (J ₄)	14 (J ₄)	90 (J ₄)	70 (J ₄)	150 (J ₄)
Chlorobenzene	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ND	ND	ND	ND	ND	3.3 (J ₄)
Chloroform	ND	ND	ND	ND	ND	ND
Methylene Chloride	3.3 (J ₆)	4.5 (J ₆)	1.5 †	1.2 (J ₄)†	4 (J ₄)	3.2 (J ₅)
Tetrachloroethene (PCE)	ND	ND	ND	1.3 (J ₄)	1.4 (J ₄)	ND
Toluene	1.8 (J ₆)	2.7 (J ₆)	ND	2.9 (J ₆)	5.5 (J ₆)	1.6 (J ₆)
Semivolatile organic compounds (µg/kg):						
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND
di-n-Butylphthalate	ND	ND	ND	61 (J ₁)	ND	ND
2-Chlorophenol	319 (J ₁)	337 (J ₁)	302 (J ₁)	255 (J ₁)	188 (J ₁)	299 (J ₁)
4-Chloro-3-methylphenol	281 (J ₁)	305 (J ₁)	288 (J ₁)	254 (J ₁)	153 (J ₁)	207 (J ₁)
Chrysene	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	42 (J ₁)†	ND	45 (J ₁)†	ND	47 (J ₁)†	36 (J ₁)†
Fluoranthene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	ND	ND	ND
2-Methylphenol (o-Cresol)	ND	ND	ND	ND	ND	ND
4-Methylphenol (p-Cresol)	ND	ND	ND	ND	ND	ND
4-Nitrophenol	251 (J ₆)	239 (J ₆)	256 (J ₆)	188 (J ₆)	ND	205 (J ₆)
di-n-Octylphthalate	ND	ND	ND	ND	ND	ND
Pentachlorophenol	185 (J ₁)†	169 (J ₁)†	178 (J ₁)†	174 (J ₁)†	ND	159 (J ₁)†
Phenanthrene	ND	ND	ND	ND	ND	ND
Phenol	369 (J ₁)	372 (J ₁)	347 (J ₁)	292 (J ₁)	207 (J ₁)	334 (J ₁)
Pyrene	ND	ND	ND	ND	ND	ND
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND
PCBs (µg/kg)	NA	NA	NA	NA	NA	NA

Table 4.8 continued

Chemical	Sample Identification and Depth					Background Range ²
	I24.2SB7 5.5-7.0 ft.	I24.2SD ³ 5.5-7.0 ft.	I24.2SB7 13.5-14.5 ft.	I24.2SB8 5.0-6.0 ft.	I24.2SB8D ⁴ 5.0-6.0 ft.	I24.2SB8 15.5-16.0 ft.
Metals (mg/kg):						
Arsenic	1.6	1.41	9.98	5.17	6.39	4.22
Barium	299 (J ₆)	125 (J ₆)	676 (J ₆)	310 (J ₆)	893 (J ₆)	127 (J ₆)
Cadmium	ND	ND	ND	ND	ND	ND
Chromium, total	10.8 (J ₄)	14.5 (J ₄)	19.8 (J ₄)	23.5 (J ₄)	29.3 (J ₄)	14.9 (J ₄)
Lead	3.78	3.75	9.87	6.62	7.84	11.6
Mercury	ND	ND	ND (J ₄)	ND	ND	ND
Nickel	9.28 (J ₄)	11.7 (J ₄)	26.2 (J ₄)	12.2 (J ₄)	23.6 (J ₄)	18.6 (J ₄)
Selenium	ND	ND	ND	ND	0.84	ND
Silver	ND	ND	ND	ND	ND	ND
Zinc	11 (J ₄)	14.4 (J ₄)	39.5 (J ₄)	17 (J ₄)	21.7 (J ₄)	25.9 (J ₄)

SWMU = Solid Waste Management Unit

* Surface soil sample.

ND = not detected

NA = not applicable

1 I24.2SS2D (0.17-0.5 ft.) is a replicate of I24.2SS2 (0.17-0.5 ft.).

2 Background concentrations are from USGS report, 1991.

3 I24.2SB7D (5.5-7.0 ft.) is a replicate of I24.2SB7 (5.5-7.0 ft.).

4 I24.2SB8D (5.0-6.0 ft.) is a replicate of I24.2SB8 (5.0-6.0 ft.).

Note: I24.2SB1 was not drilled.

† The compound was positively identified at a concentration below the method detection limit.

Data qualifiers follow the data in parentheses and are defined as follows:

J The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

R Reported result is unusable due to quality control parameters outside limits.

to 540 $\mu\text{g/kg}$. Furthermore, fluoranthene and phenanthrene were detected in SB4 (8.5-9.5') at concentrations of 100 $\mu\text{g/kg}$ and 39 $\mu\text{g/kg}$, respectively. Phenanthrene was also found in SB5 (5.0-6.0') at a concentration of 115 $\mu\text{g/kg}$. Finally, chrysene was detected in SB4 (8.5-9.5') at a concentration of 40 $\mu\text{g/kg}$, 1,2-dichlorobenzene in SB3 (6.0-7.0') at 94 $\mu\text{g/kg}$, and di-n-butylphthalate in SB8 (5.0-6.0') at 61 $\mu\text{g/kg}$.

Cyanide was detected in SB5 (5.0-6.0') and SB6 (5.5-6.5') at concentrations of 0.608 mg/kg and 2.16 mg/kg, respectively. Arsenic was detected in all soil borings within the concentration range (2-11 mg/kg), and it reached a maximum concentration of 9.98 mg/kg in SB7 (13.5-14.5'). Barium was detected above the upper background level (570 mg/kg) in three soil borings (SB2, SB7, and SB8). Barium concentrations were particularly high in SB2 (17-18'), SB7 (13.5-14.5') and SB8 (5.0-6.0'), where it was found at 1270 mg/kg, 676 mg/kg and 893 mg/kg, respectively. Cadmium was found at a concentration of 2.69 mg/kg in SB5 (5.0-6.0'), above the reported survey detection level of 2 mg/kg. Total chromium levels was found above the upper background range (74 mg/kg) in SB3 (106 mg/kg). The soil boring samples contained nickel, lead, and zinc at concentrations within the background ranges. Selenium was found at concentrations ranging from 0.59 to 0.844 mg/kg in four soil borings (SB4, SB5, SB6, and SB8). The background concentration range for selenium is <0.1 - 0.2 mg/kg.

4.3.3 Oil Separator (SWMU 24.3)

Fourteen soil gas samples and three surface soil samples were collected, and two borings were drilled at this SWMU. Four soil borings were originally planned; two were cancelled because of utility locations. A total of four soil boring samples were collected.

Soil Gas. Table 4.9 presents the soil gas analytical results for this SWMU. All target compounds were detected in the samples, although most were at or below 1 ppmv. SG3 had the highest concentrations of all compounds detected except 1,1-DCA (7 ppmv at SG10). Concentrations of target compounds in SG3 included 120 ppmv vinyl chloride, 20 ppmv 1,1-DCE, 32 ppmv 1,1-DCA, 75 ppmv 1,2-DCA, 23 ppmv TCE, 20 ppmv toluene, 13 ppmv PCE, 9 ppmv ethylbenzene, and 15 ppmv o-xylene. Benzene was only detected in SG3 (6 ppmv). The north and east sides of SWMU 24.3 appear to have the highest concentrations of VOCs detected in the soil gas.

Surface Soil. Table 4.10 shows the surface soil and soil boring analytical results. Three surface soil samples and one duplicate were collected at this SWMU. The duplicate was analyzed for TPH. Sample SS1 contained 2-hexanone, toluene, and xylene, and had the highest concentration of total VOCs (3,730 $\mu\text{g/kg}$). Methylene chloride, PCE, and chloroform were detected in low amounts in SS2 and SS3. One sample, SS2, contained acetone at 12 $\mu\text{g/kg}$.

Sample SS3 had the highest concentration of total SVOCs (5,697 $\mu\text{g/kg}$), while SS1 had the highest total number of SVOC compounds detected (five). With the exception of fluoranthene (SS1), all of the SVOCs were phthalates.

Table 4.9
Chemical Constituents Detected in Soil Gas, September and October 1993
SWM U 24.3, Oil Separator
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/ 1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
IWT 24.3 SG1	<1	13	<1	0.4 J	<1	0.4 J	<1	0.2 J	4	0.6 J	<1	1 J
IWT 24.3 SG2	5	6	<1	0.7 J	<1	<1	<1	0.1 J	1	<1	<1	4
IWT 24.3 SG3	120	20	<1	32	6	75	23	20	13	9	15	1700
IWT 24.3 SG4	<1	3	3	<1	<1	1	0.7 J	0.2 J	0.2 J	1	0.3 J	64
IWT 24.3 SG5	27	0.5 J	0.4 J	2	<1	1	<1	<1	0.9 J	0.1 J	<1	26
IWT 24.3 SG64*	<1	3	<1	2	<1	0.5 J	<1	<1	0.4 J	<1	<1	0.2 J
IWT 24.3 SG6	<1	4	<1	0.7 J	<1	0.1 J	<1	<1	0.2 J	<1	<1	0.4 J
IWT 24.3 SG7	0.9 J	2	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	3
IWT 24.3 SG9	29	1	<1	<1	<1	0.7 J	1	0.4 J	1	0.6 J	0.7 J	31
IWT 24.3 SG10	10	7	7	4	<1	0.5 J	0.4 J	0.2 J	0.7 J	0.5 J	0.5 J	11
IWT 24.3 SG11	<1	<1	<1	5	<1	<1	1	0.8 J	4	2	6	750
IWT 24.3 SG12	11	0.5 J	0.3 J	2	<1	<1	<1	<1	0.3 J	0.2 J	0.2 J	4
IWT 24.3 SG13	4	5	<1	0.4 J	<1	0.4 J	0.3 J	0.2 J	0.2 J	0.1 J	<1	7
IWT 24.3 SG14	<1	1	<1	0.6 J	<1	<1	<1	<1	0.2 J	<1	<1	0.9 J

450RBAU401SGSRT2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Note: IWT 24.3 SG8 was not collected.

Table 4.10 Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.3, Oil Separator
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth								Background Range ²
	I24.3SS1* 0.17-0.33 ft.	I24.3SS1D1* 0.17-0.33 ft.	I24.3SS2* 0.33-0.5 ft.	I24.3SS3* 0.33-0.5 ft.	I24.3SB1 5.5-6.5 ft.	I24.3SB1 13.0-14.0 ft.	I24.3SB4 6.0-7.0 ft.	I24.3SB4 11.0-11.5 ft.	
Volatile organic compounds (µg/kg):									
Acetone	ND	NA	12 (J ₄)	ND	ND	ND	ND	35	NA
Chloroform	ND	NA	1.7 (J ₁)	1.7 (J ₁)	ND	ND	ND	ND	NA
2-Hexanone	3100	NA	ND	ND	ND	ND	ND	ND	NA
Methylene chloride	ND	NA	8.7 (J ₄)	10 (J ₄)	ND	ND	ND	ND	NA
Tetrachloroethene (PCE)	ND	NA	2 (J ₅)	7.3	ND	ND	ND	ND	NA
Toluene	170 (J ₁)	NA	ND	ND	ND	ND	ND	ND	NA
Xylene, total	460 (J ₅)	NA	ND	ND	ND	ND	ND	ND	NA
Semivolatile organic compounds (µg/kg):									
Benzoic acid	ND	NA	ND	ND	ND	107 (J ₅)	ND	87.4 (J ₅)	NA
Butyl benzyl phthalate	ND	NA	ND	656 (J ₅)	ND	ND	ND	ND	NA
di-n-Butylphthalate	118 (J ₅)	NA	ND	134 (J ₅)	ND	ND	ND	ND	NA
Diethylphthalate	181 (J ₅)	NA	ND	287 (J ₅)	ND	ND	ND	ND	NA
bis(2-Ethylhexyl)phthalate	2380 (J ₁)	NA	690 (J ₁)	4620 (J ₁)	86.7 (J ₅)†	167 (J ₅)	95.1 (J ₅)	74.9 (J ₅)†	NA
Fluoranthene	151 (J ₅)	NA	ND	ND	ND	ND	ND	ND	NA
di-n-Octylphthalate	89 (J ₅)†	NA	ND	ND	ND	ND	ND	ND	NA
Cyanide (mg/kg)	ND	NA	ND	0.79 (J ₆)	ND	ND	ND	ND	NA
PCBs (µg/kg)									
Arochlor 1254	197	NA	ND	54	ND	ND	ND	ND	NA
Total petroleum hydrocarbons:									
Naphthalene (mg/kg)	42.3	47.5	48.7	47.6	ND	ND	ND	ND	NA
Gasoline components (µg/kg)	22.8 (J ₄)	12.5 (J ₄)	ND	ND	ND	ND	ND	ND	NA

Table 4.10, cont.

Chemical	Sample Identification and Depth								Background Range ²
	I24.3SS1*	I24.3SS1D1*	I24.3SS2*	I24.3SS3*	I24.3SB1	I24.3SB1	I24.3SB4	I24.3SB4	
	0.17-0.33 ft.	0.17-0.33 ft.	0.33-0.5 ft.	0.33-0.5 ft.	5.5-6.5 ft.	13.0-14.0 ft.	6.0-7.0 ft.	11.0-11.5 ft.	
Metals (mg/kg):									
Arsenic	7.66	NA	1.56	3.77	0.79	1.01	ND	1.36	2-11
Barium	304 (J6)	NA	69.5 (J6)	354 (J6)	58.7	138	67.9	34.8	47-570
Cadmium	8.92 (J6)	NA	0.94 (J6)	7.88 (J6)	ND	ND	ND	ND	<2.0
Chromium, total	180 (J4)	NA	44.1 (J4)	212 (J4)	5.41	3.41	7.81	5.79	6-74
Lead	71.3 (J4)	NA	80.7 (J4)	31.6 (J4)	1.92	0.76	1.69	1.13	<4-48
Mercury	0.1	NA	ND	ND	ND	ND	ND	ND	NA
Nickel	335 (J4)	NA	36.6 (J4)	212 (J4)	2.59	3.66	1.8	10.3	6-32
Silver	7.87 (J4)	NA	1.04 (J4)	9.98 (J4)	ND	ND	ND	ND	<2.0
Zinc	494 (J4)	NA	71 (J4)	51.1 (J4)	37.1	3.66	4.54	8.51	5-53

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable/not analyzed

¹ I24.3SS1D (0.17-0.33 ft.) is a replicate of I24.3SS1 (0.17-0.33 ft.).

² Background concentrations are from USGS report, 1991.

Note: I24.3SB2 and I24.3SB3 were not drilled.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Cyanide was detected only at SS3 at an estimated concentration of 0.79 mg/kg. PCBs were detected at two of the three locations sampled. Concentrations were 197 $\mu\text{g/kg}$ (SS1) and 54 $\mu\text{g/kg}$ (SS3).

Concentrations of naphthalene were detected in all four surface soil samples at concentrations ranging from 42.3 mg/kg to 48.7 mg/kg. Only SS1 and its duplicate had detectable concentrations of gasoline components.

Four out of the nine highest concentrations of metals were detected in SS1. Cadmium was detected in two samples, SS1 and SS3, at concentrations above the background range. Nickel and zinc were found at concentrations above the background range in all three samples.

Soil Borings. Two soil borings (SB1 and SB4) were drilled and sampled at this location. Table 4.10 shows the results of the soil boring sample analysis. Acetone was detected at a concentration of 35 $\mu\text{g/kg}$ in SB4 (11.0-11.5'). Bis(2-ethylhexyl)phthalate was detected in samples from both soil borings at concentrations ranging from 74.9 to 167 $\mu\text{g/kg}$. Benzoic acid was detected in SB1 (13.0-14.0') and SB4 (11.0-11.5') at a concentration of 107 $\mu\text{g/kg}$ and 87.4 $\mu\text{g/kg}$, respectively.

Arsenic was detected in three of the four samples at concentrations below the background range. The remaining metals were detected at concentrations within the background ranges.

4.3.4 Valve Vault (SWMU 24.4)

Soil gas and surface soil samples were not collected specifically for this SWMU. One soil boring was drilled at this SWMU, and two samples were collected.

Soil Gas. Soil gas samples I24.5SG7, I24.3SG13, and I24.2SG15 were collected within 30 feet of SWMU 24.4. Soil gas concentrations of 1 ppmv vinyl chloride and 2 ppmv 1,1-DCE were detected at I24.5SG7, the closest sampling point.

Soil Borings. Only one soil boring (SB1) was sampled at this location (Table 4.11). Acetone was detected at a concentration of 980 $\mu\text{g/kg}$ from 4.5-5.0 feet bgs and at a concentration of 4,200 $\mu\text{g/kg}$ from 10.0-11.0 feet bgs. Methylene chloride and toluene were detected at 60 $\mu\text{g/kg}$ and 7 $\mu\text{g/kg}$, respectively, from 4.5-5.0 feet bgs. Bis(2-ethylhexyl)phthalate was detected at 56 $\mu\text{g/kg}$ from 4.5-5.0 feet bgs and at 65.4 $\mu\text{g/kg}$ from 10.0-11.0 feet bgs.

All metal concentrations were within their respective background survey concentration ranges.

4.3.5 Equalization Basins (SWMU 24.5)

At this SWMU, eight soil gas samples and two surface soil samples were collected, and two borings were drilled. Three borings were planned; however, SB1 was not drilled because of underground utility concerns. A total of four soil boring samples were collected.

Soil Gas. Seven out of eleven target VOCs in soil gas samples from SWMU 24.5 were detected at or below 1 ppmv (Table 4.12). Sample SG2 contained

Table 4.11 Chemical Constituents Detected in Soils, October 1993
 SWMU 24.4, Valve Vault
 Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth		Background Range ¹
	I24.4SB1 4.5-5.0 ft.	I24.4SB1 10.0-11.0 ft.	
Volatile organic compounds ($\mu\text{g}/\text{kg}$):			
Acetone	980	4200	NA
Methylene chloride	60 (J ₁)	ND	NA
Toluene	7 (J ₅)	ND	NA
Semivolatile organic compounds ($\mu\text{g}/\text{kg}$):			
bis(2-Ethylhexyl)phthalate	56 (J ₁)†	65.4 (J ₁)†	NA
Cyanide (mg/kg)	ND	ND	NA
Metals (mg/kg):			
Arsenic	1.84	3.41	2-11
Barium	224	116	47-570
Chromium, total	9.96	12.7	6-74
Lead	4.55	2.73	< 4-48
Nickel	6.76	14.6	6-32
Zinc	10.2	17.1	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

Data qualifiers follow the data in parentheses and are defined as follows:

J The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.12
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.5, Equalization Basin
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1 - TCA/ 1,1 - DCE							TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1 - DCE (ppmv)	1,1 - DCA (ppmv)	1,1 - DCE (ppmv)	1,1 - DCA (ppmv)	1,1 - DCE (ppmv)	1,1 - DCA (ppmv)	1,1 - DCE (ppmv)						
IWT24.5 SG1	5	0.1 J	<1	<1	<1	<1	0.3 J	0.3 J	0.1 J	<1	<1	<1	<1	5
IWT24.5 SG2	6	1	<1	<1	<1	<1	0.4 J	0.1 J	0.2 J	<1	<1	<1	<1	4
IWT24.5 SG3	<1	0.9 J	<1	<1	<1	<1	0.1 J	<1	<1	<1	<1	<1	<1	0.5 J
IWT24.5 SG4	<1	1	<1	<1	<1	0.7 J	<1	<1	<1	<1	<1	<1	<1	0.1 J
IWT24.5 SG5	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	<1	<1	<1	<1	0.3 J
IWT24.5 SG7	1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3
IWT24.5 SG8	1	3	<1	<1	<1	0.8 J	0.3 J	<1	<1	<1	0.3 J	<1	<1	5

450RBAU01SGSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Note: IWT24.5 SG6 was not collected.

concentrations of vinyl chloride (6 ppmv) and 1,1,1-TCA/1,2-DCE (1 ppmv). The highest concentration of 1,1-DCE in samples from the SWMU was 3 ppmv in SG8. The north side of SWMU 24.5 appears to have the highest concentration of VOCs in the soil gas. A sample was collected from SG6 but not analyzed because of instrument problems.

Surface Soils. Surface soil sample SS2 had the highest concentration of VOCs for four out of five compounds found (acetone, chloroform, methylene chloride, and PCE) (Table 4.13). Toluene was detected in SS1 at 3.1 $\mu\text{g/kg}$.

With the exception of pyrene in SS2, the only SVOCs detected in the two surface soil samples were phthalates. Only one SVOC was detected in SS1, bis(2-ethylhexyl)phthalate (314 $\mu\text{g/kg}$).

Cadmium and chromium were detected above background concentrations in both samples. Cadmium was detected above background concentrations (<2 mg/kg) in SS2 at 3.23 mg/kg. The chromium concentration in SS1 (85.3 mg/kg) was above the upper background range (6-74 mg/kg). Barium and lead were detected below background ranges in both samples. No cyanide or PCBs were detected.

Soil Borings. Two soil borings (SB2 and SB3) were sampled at this location (Table 4.13). Acetone and methylene chloride were detected in both soil borings at concentrations ranging from 26 to 390 $\mu\text{g/kg}$ and 9.6 to 30 $\mu\text{g/kg}$, respectively. PCE was detected in SB2 (3.0-3.5') at a concentration of 3.8 $\mu\text{g/kg}$. Toluene was also detected in SB2 to a maximum concentration of 3.3 $\mu\text{g/kg}$ from 3.0 to 3.5 feet bgs. Bis(2-ethylhexyl)phthalate was detected in SB2 (15.0-16.0') and SB3 (3.5-5.0') at a concentration of 65.3 to 67.2 $\mu\text{g/kg}$.

Arsenic was detected within the average background range (2-11 mg/kg) in all samples. Barium, total chromium, and selenium were all detected above background ranges in SB2 from 3.0-3.5 feet bgs. In SB2 (3.0-3.5'), the concentration of barium was 695 mg/kg, above the upper background concentration range of 570 mg/kg.

4.3.6 Main Flow Valve (SWMU 24.6)

Four soil gas samples were collected, and one boring was drilled. Three soil boring samples were collected.

Soil Gas. Table 4.14 presents the soil gas analytical results. Concentrations of 1,1-DCE in SG1, SG3, and SG4 were 2 ppmv, 1 ppmv, and 1 ppmv, respectively. 1,2-DCA was found in samples SG2, SG3, and SG4 at concentrations below the quantitation limit (1 ppmv). Traces of 1,1,1-TCA/1,2-DCE and PCE were found in SG3 and SG4, respectively.

Soil Borings. Only one soil boring (SB1) was sampled at this location (Table 4.15). Acetone and methylene chloride were found at concentrations ranging from 26 to 37 $\mu\text{g/kg}$ and 8.5 to 10 $\mu\text{g/kg}$, respectively. Toluene was found in SB1 (7.0-8.5') at a low concentration of 1.1 $\mu\text{g/kg}$. Bis(2-ethylhexyl)phthalate was found in SB1 (14.0-16.0') at a concentration of 56.2 $\mu\text{g/kg}$.

Table 4.13 Chemical Constituents Detected in Soils, October 1993
SWMU 24.5, Equalization Basin
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth							Background Range ²
	I24.5SS1*	I24.5SS2*	I24.5SB2	I24.5SB2	I24.5SB2D ¹	I24.5SB3		
	0.17-0.33 ft.	0.17-0.33 ft.	3.0-3.5 ft.	15.0-16.0 ft.	15.0-16.0 ft.	3.5-5.0 ft.		
Volatile organic compounds (µg/kg):								
Acetone	30 (J4)	36 (J4)	390	28	26	56	NA	
Chloroform	1.7 (J1)	8.3 (J5)	ND	ND	ND	ND	NA	
Methylene chloride	15 (J4)	40 (J4)	30 (J1)	13 (J1)	12 (J1)	9.6 (J1)	NA	
Tetrachloroethene (PCE)	7.5	18 (J5)	3.8 (J5)	ND	ND	ND	NA	
Toluene	3.1 (J1)	ND	3.3 (J5)	1.9 (J5)	1.5 (J5)	ND	NA	
Semivolatile organic compounds (µg/kg):								
di-n-Butylphthalate	ND	252 (J5)	ND	ND	ND	ND	NA	
Diethylphthalate	ND	484 (J5)	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	314 (J1)	6060 (J1)	ND	67.2 (J1)†	ND	65.3 (J1)†	NA	
di-n-Octylphthalate	ND	152 (J5)	ND	ND	ND	ND	NA	
Pyrene	ND	100 (J5)	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)	ND	ND	NA	NA	NA	NA	NA	
Metals (mg/kg):								
Arsenic	3.34	1.34	3.13	4.06	2.09	ND	2-11	
Barium	300 (J6)	177 (J6)	695	48.6	31.9	78.1	47-570	
Cadmium	1.88 (J6)	3.23 (J6)	ND	ND	ND	0.39	<2.0	
Chromium, total	85.3 (J4)	45.1 (J4)	34.6 (J4)	17 (J4)	8.92 (J4)	7.85 (J4)	6-74	

Table 4.13, cont.

Chemical	Sample Identification and Depth						Background Range ²
	I24.SSB1* 0.17-0.33 ft.	I24.SSB2* 0.17-0.33 ft.	I24.SSB2 3.0-3.5 ft.	I24.SSB2 15.0-16.0 ft.	I24.SSB2D ¹ 15.0-16.0 ft.	I24.SSB3 3.5-5.0 ft.	
Metals, cont.							
Lead	11.6 (J4)	14.5 (J4)	4.18 (J4)	5.85 (J4)	1.76 (J4)	1.07 (J4)	<4-48
Mercury	ND	0.17	ND	ND	ND	ND	NA
Nickel	26.2 (J4)	23.4 (J4)	18.9 (J4)	16.9 (J4)	9.03 (J4)	3.21 (J4)	6-32
Silver	1.04 (J4)	2 (J4)	ND	ND	ND	ND	<0.1-0.2
Selenium	ND	ND	0.81	ND	ND	ND	<2.0
Zinc	46.1 (J4)	41.7 (J4)	25.3 (J4)	22.6 (J4)	9.8 (J4)	3.92 (J4)	5-53

* Surface soil sample

ND = not detected

NA = not applicable

¹ I24.SSB2D (15.0-16.0 ft.) is a replicate of I24.SSB2 (15.0-16.0 ft.).

² Background concentrations are from USGS report, 1991.

Note: I24.SSB1 was not drilled.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.14
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.6, Main Flow Valve
Tinker AFB, Oklahoma

Sample	1,1,1-TCA/ Vinyl Chloride										Unknowns (ppmv)
	Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	o-Xylene (ppmv)	
IWT 24.6 SG1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J
IWT 24.6 SG2	<1	0.5 J	<1	<1	<1	0.1 J	<1	<1	<1	<1	<1
IWT 24.6 SG38*	<1	<1	<1	<1	<1	0.3 J	<1	<1	<1	<1	0.5 J
IWT 24.6 SG3	<1	1	<1	0.2 J	<1	0.1 J	<1	<1	<1	<1	0.5 J
IWT 24.6 SG4	<1	1	<1	<1	<1	0.2 J	<1	<1	0.2 J	<1	<1

430RBAU401SGSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.15 Chemical Constituents Detected in Soils, October 1993
SWMU 24.6, Main Flow Valve
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth			Background Range ²
	I24.6SB1 7.0-8.5 ft.	I24.6SB1 14.0-16.0 ft.	I24.6SB1D ¹ 14.0-16.0 ft.	
Volatile organic compounds ($\mu\text{g}/\text{kg}$):				
Acetone	26	37	58	NA
Methylene chloride	10 (J ₁)	8.5 (J ₁)	10 (J ₁)	NA
Toluene	1.1	ND	ND	NA
Semivolatile organic compounds ($\mu\text{g}/\text{kg}$):				
bis(2-Ethylhexyl)phthalate	ND	56.2 (J ₁)†	37.4 (J ₁)†	NA
Cyanide (mg/kg)	ND	ND	ND	NA
Metals (mg/kg):				
Arsenic	3.67	1.52	1.74	2-11
Barium	60.7	29	45.8	47-570
Chromium, total	13.3	9.79	10.4	6-74
Lead	4.64	3.59	3.36	<4-48
Nickel	9.29	7.5	7.7	6-32
Selenium	0.65	ND	ND	<0.1-0.2
Zinc	12.6	10.2	10.6	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ I24.6SB1D (14.0-16.0 ft.) is a replicate of I24.6SB1 (14.0-16.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

Data qualifiers follow the data in parentheses and are defined as follows:

J The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

In the sample collected from SB1 (7.0 to 8.5 feet bgs) selenium was found at a concentration of 0.65 mg/kg, above the average background range of <0.1-0.2 mg/kg. All other metals were found at concentrations within the background ranges.

4.3.7 Mixing Basins 1, 2, and 3 (SWMU 24.7)

At this SWMU, four soil gas samples were collected and two soil borings were drilled. Three soil boring samples were collected.

Soil Gas. Chlorinated solvents 1,1-DCE and 1,1,1-TCA/1,2-DCE were detected (Table 4.16). An estimated quantity of 1 ppmv 1,1-DCE was detected in SG3. Sample SG1 did not contain target VOC concentrations above the detection limit. Samples SG2 and SG3 both contained 1,1-DCE and 1,1,1-TCA/1,2-DCE at concentrations below the quantitation limit.

Soil Borings. Two soil borings (SB1 and SB2) were drilled at this location (Table 4.17). The concentration of acetone was relatively high in SB2 (11.0-13.0'), where it was found at 270 µg/kg. Acetone was also found in SB1 (8.0-10.0') at a lower concentration of 62 µg/kg. In addition, methylene chloride was found in SB1 (8.0-10.0') at a concentration of 22 µg/kg. Bis(2-ethylhexyl)phthalate was detected in both soil borings at concentrations ranging from 65.6 to 166 µg/kg.

All metal concentrations were within the background concentration ranges.

4.3.8 Solids Contact Clarifier (SWMU 24.8)

Nine soil gas samples were collected and four soil borings were drilled at this SWMU. Nine soil boring samples were collected.

Soil Gas. Four out of eleven target VOCs were detected in the nine soil gas samples collected from SWMU 24.8 (Table 4.18). The highest concentrations of 1,1-DCE and 1,1,1-TCA/1,2-DCE, 6 and 3 ppmv, respectively, were found in SG7. Concentrations of 1,1-DCA (SG8 and SG9) and PCE (SG8) were below the 1 ppmv quantitation limit. Samples SG8 and SG9 contained three out of four chemicals found at this SWMU. VOCs were not detected in samples SG1 and SG4.

Soil Borings. Four soil borings (SB1 through SB4) were sampled at this location. The results are presented in Table 4.19. Acetone was detected in all soil borings at concentrations ranging from 21 to 110 µg/kg. Methylene chloride was detected in SB1, SB2, and SB4, up to a maximum concentration of 13 µg/kg. Bis(2-ethylhexyl)phthalate was detected in SB1 and SB2 up to a maximum concentration of 89 µg/kg. Phenolic compounds were detected in SB4. These compounds were measured at concentrations similar to concentrations of laboratory spiking compounds, and are thought to be the result of laboratory contamination.

The highest concentration (678 mg/kg) of barium was found in SB2 from 10.0 to 11.0 feet bgs. This concentration is above the upper background range of 570 mg/kg. All other metal concentrations were below or within the background ranges.

Table 4.16
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.7, Mixing Basins 1, 2, and 3
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/ 1,1-DCE					Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	1,2-DCA (ppmv)	1,2-DCE (ppmv)								
IWT24.7 SG1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.2 J
IWT24.7 SG2	<1	0.7 J	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J
IWT24.7 SG3	<1	1.0 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.2 J
IWT24.7 SG4	<1	0.6 J	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
IWT24.7 SG60*	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J

450RBAU401SGSR572.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.17 Chemical Constituents Detected in Soils, November 1993
SWMU 24.7, Mixing Basins 1, 2, 3
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth			Background Range ¹
	I24.7SB1 4.0-6.0 ft.	I24.7SB1 8.0-10.0 ft.	I24.7SB2 11.0-13.0 ft.	
Volatile organic compounds (µg/kg):				
Acetone	ND	62 (J ₁)	270 (J ₁)	NA
Methylene chloride	ND	22	ND	NA
Semivolatile organic compounds (µg/kg):				
bis(2-Ethylhexyl)phthalate	65.6†	166 (J ₅)	115 (J ₅)	NA
Cyanide (mg/kg)	ND	ND	ND	NA
Metals (mg/kg):				
Arsenic	2.16	2.68	1.12	2-11
Barium	344	247	270	47-570
Cadmium	ND	ND	ND	<2.0
Chromium, total	6.15	36.5	6.41	6-74
Lead	2.7	5.94	7.87	<4-48
Nickel	4.64	6.41	2.14	6-32
Zinc	6.26	14.1	5.06	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not analyzed

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.18
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.8, Solids Clarifier
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/ 1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
IWT24.8 SG1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.8 SG2	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.7 J
IWT24.8 SG3	<1	0.6 J	<1	1	<1	<1	<1	<1	<1	<1	<1	0.4 J
IWT24.8 SG4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.5 J
IWT24.8 SG5	<1	0.8 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.8 SG6	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J
IWT24.8 SG61*	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.8 SG7	<1	6	<1	3	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.8 SG8	<1	<1	<1	0.1 J	<1	0.1 J	<1	<1	0.2 J	<1	<1	0.3 J
IWT24.8 SG9	<1	1	<1	0.3 J	<1	0.2 J	<1	<1	<1	<1	<1	0.6 J

450RBAU401SGRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene

DCE = dichloroethene PCE = tetrachloroethene

TCA = trichloroethane ppmv = parts per million vapor

Table 4.19 Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.8, Solids Clarifier
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth										Background Range ²
	I24.8SB1 5.0-7.0 ft.	I24.8SB1 14.0-16.0 ft.	I24.8SB1D ¹ 14.0-16.0 ft.	I24.8SB2 10.0-11.0 ft.	I24.8SB2 17.0-17.5 ft.	I24.8SB3 6.0-7.0 ft.	I24.8SB3 17.0-18.0 ft.	I24.8SB4 4.0-5.5 ft.	I24.8SB4 8.0-9.5 ft.		
Volatile organic compounds (µg/kg):											
Acetone	42 (J ₆)	110 (J ₆)	84 (J ₆)	32 (J ₁)	36 (J ₁)	22 (J ₁)	34 (J ₁)	23 (J ₄)	21 (J ₄)	NA	
Methylene chloride	ND	9.2 (J ₁)	10 (J ₁)	13 (J ₁)	12 (J ₁)	ND	ND	ND	7 (J ₄)	NA	
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	2.3 (J ₆)	NA	
Semivolatile organic compounds (µg/kg):											
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	291 (J ₁)	286 (J ₁)	NA	
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	290 (J ₁)	313 (J ₁)	NA	
bis(2-Ethylhexyl)phthalate	40 (J ₁)†	ND	89 (J ₁)†	64 (J ₁)†	44 (J ₁)†	ND	ND	ND	ND	NA	
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	199 (J ₆)	196 (J ₆)	NA	
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	129 (J ₁)	216 (J ₁)	NA	
Phenol	ND	ND	ND	ND	ND	ND	ND	342 (J ₁)	356 (J ₁)	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Metals (mg/kg):											
Arsenic	3	3.16	4.13	2.99	2.9	ND	2.36	2.86	5.28	2-11	
Barium	236	173	204	678	240	71.8	41	215 (J ₆)	323 (J ₆)	47-570	
Cadmium	0.89	0.68	0.78	ND	ND	0.38	ND	ND	ND	<2.0	

Table 4.19, cont.

Chemical	Sample Identification and Depth									
	I24.8SB1 5.0-7.0 ft.	I24.8SB1 14.0-16.0 ft.	I24.8SB1D ¹ 14.0-16.0 ft.	I24.8SB2 10.0-11.0 ft.	I24.8SB2 17.0-17.5 ft.	I24.8SB3 6.0-7.0 ft.	I24.8SB3 17.0-18.0 ft.	I24.8SB4 4.0-5.5 ft.	I24.8SB4 8.0-9.5 ft.	Background Range ²
Metals, cont.										
Chromium, total	13.1	7.68	8.93	14.3	7.3	2.77 (J ₄)	9.08 (J ₄)	13.5 (J ₄)	10.7 (J ₄)	6-74
Lead	4.89	3.39	4.35	6.57 (J ₄)	3.01 (J ₄)	1.17	3.66	4.77	2.81	<4-48
Nickel	7.45	5.99	6.69	10.5	9.15	3.3	2.71	8.8 (J ₄)	9.66 (J ₄)	6-32
Zinc	11.1	6.78	8.37	15.6	9.73	3.51	3.89	13.2 (J ₄)	12 (J ₄)	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ I24.8SB1D (14.0-16.0 ft.) is a replicate of I24.8SB1 (14.0-16.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

4.3.9 Wet Well Lift Station (SWMU 24.9)

At this SWMU, four soil gas samples were collected and two borings were drilled. Three soil boring samples were collected.

Soil Gas. From the four soil gas samples collected, nine of the eleven target VOCs were detected (Table 4.20). Six target compounds were detected in SG1, and all were below the quantitation limit. PCE was detected in three samples (SG1, SG2, and SG3), and all were below 1 ppmv. 1,1-DCE was detected in three samples at concentrations ranging from 0.8 ppmv (SG2) to 35 ppmv (SG3). 1,1-DCE was the only target compound detected above the quantitation limit.

Soil Borings. Two soil borings (SB1 and SB2) were sampled at this location (Table 4.21). Acetone and methylene chloride were detected in both soil borings at concentrations ranging from 16 to 63 $\mu\text{g/kg}$ and 1.2 to 13 $\mu\text{g/kg}$, respectively. PCE and toluene were detected in SB2 (2.0-4.0') at a concentration of 10 $\mu\text{g/kg}$ and 5.8 $\mu\text{g/kg}$, respectively. Also in SB2 (2.0-4.0'), bis(2-ethylhexyl)phthalate was detected at a concentration of 46 $\mu\text{g/kg}$ and four variations of phenol were detected at concentrations ranging from 206 to 302 $\mu\text{g/kg}$.

Selenium was detected at 0.54 mg/kg, above the background range of <0.2 mg/kg. All other metals were within background ranges.

4.3.10 Softener Basins (SWMU 24.10)

Six soil gas samples were collected and five soil borings were drilled at this SWMU. Ten soil boring samples were collected.

Soil Gas. Four out of eleven target VOCs were detected in the soil gas samples (Table 4.22). The compounds 1,1,1-TCA/1,2-DCE were detected in the samples at concentrations ranging from 0.2 to 2 ppmv. Sample SG6 had the highest concentration, 1 ppmv, of 1,1-DCE. Concentrations of 1,2-DCA in the samples were below the 1 ppmv quantitation limit. PCE was detected in one sample, SG3, at 3 ppmv.

Soil Borings. Five soil borings (SB1 through SB5) were sampled at this unit (Table 4.23). Acetone was detected in all soil borings at concentrations ranging from 11 to 69 $\mu\text{g/kg}$. Methylene chloride was detected in all soil borings except SB4 at concentrations ranging from 3.3 to 16 $\mu\text{g/kg}$. PCE was detected in SB1, SB2, and SB3 at concentrations ranging from non-detect in SB2 (9.0-10.5') to 7.4 $\mu\text{g/kg}$ in SB1 (4.0-6.0'). Toluene was detected in SB1 and SB2 up to a maximum concentration of 2.0 $\mu\text{g/kg}$. Fifteen SVOCs were detected in SB3 (6.0-7.0') at concentrations ranging from 45 $\mu\text{g/kg}$ (bis[2-ethylhexyl]phthalate) to 4,000 $\mu\text{g/kg}$ (phenanthrene). Also in SB3 (15.0-16.0'), six SVOCs were detected but at lower concentrations, ranging from 35 $\mu\text{g/kg}$ (benzo[k]fluoranthene) to 160 $\mu\text{g/kg}$ (fluoranthene). In addition, bis(2-ethylhexyl)phthalate was detected in SB1 (4.0-6.0' and 13.0-15.0') and SB5 (6.0-7.0') at concentrations ranging from 41.2 to 89 $\mu\text{g/kg}$.

Arsenic was not detected in four soil boring samples. The maximum concentration of arsenic was 4.0 mg/kg in SB5 (6.0-7.0'). The maximum

Table 4.20
 Chemical Constituents Detected in Soil Gas, September and October 1993
 SWMU 24.9, Wet Well Lift Station
 Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/ 1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
IWT 24.9 SG1	<1	<1	<1	0.3 J	<1	<1	0.7 J	0.4 J	0.8 J	0.2 J	0.3 J	0.3 J
IWT 24.9 SG2	<1	0.8 J	<1	<1	<1	<1	<1	<1	0.8 J	<1	<1	0.1 J
IWT 24.9 SG3	<1	35	<1	<1	<1	<1	<1	<1	0.2 J	<1	<1	0.1 J
IWT 24.9 SG4	<1	27	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
IWT 24.9 SG62*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.2 J

490RBAU001SGRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
 DCE = dichloroethene PCE = tetrachloroethene
 TCA = trichloroethane ppmv = parts per million vapor

Table 4.21 Chemical Constituents Detected in Soils, November 1993
SWMU 24.9, Wet Well Lift Station
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth			Background Range ¹
	I24.9SB1 10.5-11.5 ft.	I24.9SB1 16.5-17.5 ft.	I24.9SB2 2.0-4.0 ft.	
Volatile organic compounds (μg/kg):				
Acetone	63 (J ₁)	51 (J ₁)	16 (J ₄)	NA
Methylene chloride	ND	13 (J ₁)	1.2 (J ₄)	NA
Tetrachloroethene (PCE)	ND	ND	10 (J ₄)	NA
Toluene	ND	ND	5.8 (J ₆)	NA
Semivolatile organic compounds (μg/kg):				
4-Chloro-3-methylphenol	ND	ND	245 (J ₁)	NA
2-Chlorophenol	ND	ND	285 (J ₁)	NA
bis(2-Ethylhexyl)phthalate	ND	ND	46 (J ₁)†	NA
4-Nitrophenol	ND	ND	206 (J ₆)	NA
Phenol	ND	ND	302 (J ₁)	NA
Cyanide (mg/kg)	ND	ND	ND	NA
Metals (mg/kg):				
Arsenic	3.92	ND	3	2-11
Barium	101	132	397 (J ₆)	47-570
Chromium, total	9.74	7.36	26.6 (J ₄)	6-74
Lead	5.82 (J ₄)	1.09 (J ₄)	7.71	<4-48
Nickel	3.49	5.43	13.9 (J ₄)	6-32
Selenium	ND	ND	0.54	<0.1-0.2
Silver	ND	ND	0.21	<2.0
Zinc	5.61	6.16	17.9 (J ₄)	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.22
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.10, Softener Basins
Tinker AFB, Oklahoma

Sample	1,1,1-TCA/										Unknowns (ppmv)
	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	o-Xylene (ppmv)	
IWT24.10 SG1	<1	0.8 J	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1
IWT24.10 SG2	<1	0.9 J	<1	0.4 J	<1	0.1 J	<1	<1	<1	<1	<1
IWT24.10 SG3	<1	0.3 J	<1	0.4 J	<1	0.2 J	<1	<1	3	<1	0.1 J
IWT24.10 SG4	<1	<1	<1	0.5 J	<1	0.1 J	<1	<1	<1	<1	0.3 J
IWT24.10 SG5	<1	<1	<1	0.2 J	<1	<1	<1	<1	<1	<1	2
IWT24.10 SG56*	<1	1.0 J	<1	2	<1	0.2 J	<1	<1	<1	<1	0.2 J
IWT24.10 SG6	<1	1	<1	0.6 J	<1	0.7 J	<1	<1	<1	<1	0.2 J

450RBAU40\SGS872.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.23 Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.10, Softener Basins
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth											Background Range ¹
	I24.10SB1 4.0-6.0 ft.	I24.10SB1 13.0-15.0 ft.	I24.10SB2 9.0-10.5 ft.	I24.10SB2 16.0-18.0 ft.	I24.10SB2 6.0-7.0 ft.	I24.10SB3 15.0-16.0 ft.	I24.10SB3 9.0-10.0 ft.	I24.10SB4 13.5-14.0 ft.	I24.10SB5 6.0-7.0 ft.	I24.10SB5 13.0-14.0 ft.		
Volatile organic compounds (µg/kg):												
Acetone	16 (J6)	37 (J6)	69 (J6)	48 (J6)	20 (J1)	26 (J1)	11 (J1)	ND	56 (J1)	43 (J1)	NA	
Methylene chloride	12 (J1)	16 (J1)	10 (J1)	15 (J1)	3.3 (J1)	5.2 (J1)	ND	ND	3.8 (J1)	4.3 (J1)	NA	
Tetrachloroethene (PCE)	7.4	1.3 (J5)	ND	5.6 (J5)	4.9 (J5)	4.1 (J5)	ND	ND	ND	ND	NA	
Toluene	1.2 (J5)	2 (J5)	1.2 (J5)	1.8 (J5)	ND	ND	ND	ND	ND	ND	NA	
Semivolatile organic compounds (µg/kg):												
Acenaphthene	ND	ND	ND	ND	270 (J5)	ND	ND	ND	ND	ND	NA	
Anthracene	ND	ND	ND	ND	1200	ND	ND	ND	ND	ND	NA	
Benzo(a)anthracene	ND	ND	ND	ND	1300	ND	ND	ND	ND	ND	NA	
Benzo(a)pyrene	ND	ND	ND	ND	1100	ND	ND	ND	ND	ND	NA	
Benzo(b)fluoranthene	ND	ND	ND	ND	1100	42 (J5)†	ND	ND	ND	ND	NA	
Benzo(g,h,i)perylene	ND	ND	ND	ND	350 (J5)	ND	ND	ND	ND	ND	NA	
Benzo(k)fluoranthene	ND	ND	ND	ND	1200	35 (J5)†	ND	ND	ND	ND	NA	
Chrysene	ND	ND	ND	ND	ND	50 (J5)	ND	ND	ND	ND	NA	
Dibenz(a,h)anthracene	ND	ND	ND	ND	180 (J5)	ND	ND	ND	ND	ND	NA	
Dibenzofuran	ND	ND	ND	ND	120 (J5)	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	89 (J1)†	50 (J1)†	ND	ND	45 (J1)†	55 (J1)†	ND	ND	41.2 (J1)†	ND	NA	
Fluorene	ND	ND	ND	ND	400	ND	ND	ND	ND	ND	NA	
Fluoranthene	ND	ND	ND	ND	3600	160 (J5)	ND	ND	ND	ND	NA	
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	ND	380	ND	ND	ND	ND	ND	NA	
Phenanthrene	ND	ND	ND	ND	4000	110 (J5)	ND	ND	ND	ND	NA	
Pyrene	ND	ND	ND	ND	2400	94 (J5)	ND	ND	ND	ND	NA	

Table 4.23, cont.

Chemical	Sample Identification and Depth											Background Range ¹
	I24.10SB1 4.0-6.0 ft.	I24.10SB1 13.0-15.0 ft.	I24.10SB2 9.0-10.5 ft.	I24.10SB2 16.0-18.0 ft.	I24.10SB2 6.0-7.0 ft.	I24.10SB3 15.0-16.0 ft.	I24.10SB3 9.0-10.0 ft.	I24.10SB4 13.5-14.0 ft.	I24.10SB5 6.0-7.0 ft.	I24.10SB5 13.0-14.0 ft.		
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Metals (mg/kg):												
Arsenic	1.59	ND	ND	ND	2.56	3.36	1.65	ND	4	2.06	2-11	
Barium	240	114	288	124	244	393	99.4	28.2	111	32.5	47-570	
Cadmium	ND	ND	ND	ND	0.55	1.92	ND	ND	ND	ND	<2.0	
Chromium, total	16.8	2.52	4.49	4.92	30	29.4	5.84 (J ₄)	9.23 (J ₄)	11.2 (J ₄)	4.23 (J ₄)	6-74	
Lead	2.86	0.72	1.91	1.08	4.79 (J ₄)	9.11 (J ₄)	2.42	0.89	4.78	1.83	<4-48	
Nickel	8.46	1.8	3.37	5.16	12.4	13.3	6.28	3.67	11.4	3.09	6-32	
Silver	0.21	ND	ND	ND	0.22	0.24	ND	ND	ND	ND	<2.0	
Zinc	9.31	2.04	5.05	4.8	16.6	20.5	7.16	2.56	14.9	3.77	5-53	

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

concentration of barium, 393 mg/kg, was found in SB3 (15.0-16.0'). Also in SB3 (15.0-16.0'), the sample with the greatest concentration of cadmium was found. Total chromium was found at a concentration of 30 mg/kg in SB3 (6.0-7.0'), within the background range.

4.3.11 Activated Sludge Unit (SWMU 24.11)

At this SWMU, seven soil gas samples were collected and four soil borings were drilled. Ten soil boring samples were collected. Tables 4.24 and 4.25 present the results of the soil gas and soil boring samples.

Soil Gas. Two compounds, 1,1-DCE and 1,1,1-TCA/1,2-DCE, were detected at concentrations above the quantitation limit. The compound 1,1-DCE was found in samples SG2 (27 ppmv), SG3 (1 ppmv), and SG6 (1 ppmv). SG3 contained 5 ppmv of 1,1,1-TCA/1,2-DCE. SG3 also contained trace amounts of 1,2-DCE and PCE.

Soil Borings. A total of four soil borings (SB1 through SB4) were sampled at this location. Acetone and methylene chloride were found in all soil borings at concentrations ranging from 17 to 62 $\mu\text{g/kg}$ and 4.4 to 23 $\mu\text{g/kg}$, respectively. PCE was found in SB2 (13.0-14.0') at a concentration of 1.6 $\mu\text{g/kg}$. Bis(2-ethylhexyl)phthalate was found in all soil borings at concentrations ranging from 49 to 230 $\mu\text{g/kg}$. Di-n-butylphthalate was detected in SB4 up to a maximum concentration of 380 $\mu\text{g/kg}$. Phenol and four additional phenol compounds (2-chlorophenol, 4-chloro-3-methylphenol, 4-nitrophenol, and pentachlorophenol) were detected in SB1 and SB4 at similar concentrations, ranging from 140 to 380 $\mu\text{g/kg}$.

Concentration of arsenic were within the background range (2-11 mg/kg) in all borings except SB3 (8.0-9.0'). Arsenic concentrations reached a maximum of 12.3 mg/kg in SB1 (8.0-9.0'). In borings SB1 and SB4, cadmium was found at concentrations ranging from 1.07 to 3.31 mg/kg, background range is <2 mg/kg. Total chromium concentrations in SB1 (4.0-5.0') and SB4 (3.0-4.0') was found at concentrations ranging from 25.1 to 41.8 mg/kg, within the background range.

4.3.12 Secondary Clarifiers (SWMU 24.12)

Twelve soil gas samples were collected and six soil borings were drilled at this SWMU. Twelve soil boring samples were collected.

Soil Gas. Four of the eleven target VOCs were detected in the twelve soil gas samples collected from SWMU 24.12 (Table 4.26). The compound 1,1-DCE was found in every sample except SG2 at concentrations ranging from 0.3 (SG11) to 2 ppmv (SG3). Trace amounts of PCE were found in three samples, SG2, SG5, and SG11. Trace amounts of 1,2-DCA and 1,1,1-TCA/1,2-DCE were found in five samples.

Soil Borings. A total of six soil borings (SB1 through SB6) were sampled at this location (Table 4.27). The VOCs acetone and methylene chloride were detected in all soil borings up to maximum concentrations of 92 $\mu\text{g/kg}$ and 16 $\mu\text{g/kg}$, respectively. PCE was detected in SB3 (4.0-6.0') and SB6 (15.0-16.0') at concentrations of 33 $\mu\text{g/kg}$ and 1.3 $\mu\text{g/kg}$, respectively. Toluene was detected in

Table 4.24
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.11, Activated Sludge Unit
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/										
	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)	
IWT24.11 SG1	<1	0.1 J	<1	<1	<1	<1	<1	<1	<1	<1	0.2 J	
IWT24.11 SG2	<1	27	<1	0.3 J	<1	<1	<1	<1	<1	<1	0.4 J	
IWT24.11 SG3	<1	1	<1	5	<1	0.2 J	<1	0.3 J	<1	<1	0.5 J	
IWT24.11 SG4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J	
IWT24.11 SG5	<1	0.7 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	
IWT24.11 SG6	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
IWT24.11 SG7	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	

450RPA11401SGSRT2.WK1

450REBAU401SGSRT2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.25. Chemical Constituents Detected in Soils, November 1993
SWMU 24.11, Activated Sludge Unit
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth										Background Range ³
	I24.11SB1 4.0-5.0 ft.	I24.11SB1D ¹ 4.0-5.0 ft.	I24.11SB1 8.0-9.0 ft.	I24.11SB2 6.0-7.0 ft.	I24.11SB2 13.0-14.0 ft.	I24.11SB3 4.0-6.0 ft.	I24.11SB3 8.0-9.0 ft.	I24.11SB4 3.0-4.0 ft.	I24.11SB4D ² 3.0-4.0 ft.	I24.11SB4 8.0-9.0 ft.	
Volatile organic compounds (µg/kg):											
Acetone	ND	ND	17 (J ₁)	32 (J ₁)	41 (J ₁)	62 (J ₁)	36 (J ₁)	24 (J ₁)	25 (J ₁)	42 (J ₁)	NA
Methylene chloride	13 (J ₁)	13 (J ₁)	19 (J ₁)	4.5 (J ₁)	4.4 (J ₁)	21	ND	11 (J ₁)	9.6 (J ₁)	23 (J ₁)	NA
Tetrachloroethene (PCE)	ND	ND	ND	ND	1.6 (J ₅)	ND	ND	ND	ND	ND	NA
Semivolatile organic compounds (µg/kg):											
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	380	65 (J ₅)	NA
4-Chloro-3-methylphenol	310 (J ₁)	310 (J ₁)	300 (J ₁)	ND	ND	ND	ND	320 (J ₁)	310 (J ₁)	360 (J ₁)	NA
2-Chlorophenol	280 (J ₁)	300 (J ₁)	300 (J ₁)	ND	ND	ND	ND	300 (J ₁)	300 (J ₁)	340 (J ₁)	NA
bis(2-Ethylhexyl)phthalate	70 (J ₅)†	59 (J ₅)†	68 (J ₅)†	49 (J ₁)†	83 (J ₁)†	72.2 (J ₅)†	230 (J ₅)	79 (J ₅)†	85 (J ₅)†	81 (J ₅)†	NA
4-Nitrophenol	210 (J ₁)	230 (J ₁)	240 (J ₁)	ND	ND	ND	ND	280 (J ₁)	250 (J ₁)	300 (J ₁)	NA
Pentachlorophenol	140 (J ₁)†	160 (J ₁)†	190 (J ₁)†	ND	ND	ND	ND	240 (J ₁)†	240 (J ₁)†	310 (J ₁)	NA
Phenol	260 (J ₁)	300 (J ₁)	300 (J ₁)	ND	ND	ND	ND	280 (J ₁)	280 (J ₁)	310 (J ₁)	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Metals (mg/kg):											
Arsenic	3.46	4.12	12.3	6.96	4.34	1.52	0.96	4.45	3.93	3.49	2-11
Barium	258	296	390	132	31.8	93.4	56.5	314	221	196	47-570
Cadmium	1.62	2.17	2.54	ND	ND	ND	ND	3.31	3.04	1.07	<2.0
Chromium, total	17.7	25.1	16.9	14	3.96	6.72	3.29	38.4	41.8	10.3	6-74
Lead	6.05	8.14	8.27	5.82 (J ₄)	2.81 (J ₄)	3.04	2.12	13.1	13.4	3.24	<4-48
Nickel	10	12	11.8	15.1	2.68	5.42	2.65	16.1	16.1	8.85	6-32
Silver	0.108	0.217	ND	ND	ND	ND	ND	0.68	0.79	ND	<2.0
Zinc	15.7	20.2	17.6	17.6	3.45	6.18	3.5	29.1	30	10.7	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ I24.11SB1D (4.0-5.0 ft.) is a replicate of I24.11SB1 (4.0-5.0 ft.).

² I24.11SB4D (3.0-4.0 ft.) is a replicate of I24.11SB4 (3.0-4.0 ft.).

³ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.26
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.12, Secondary Clarifier
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/ 1,1-DCE											TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	1,1-DCE (ppmv)						
IWT 24.12 SG1	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.4 J	
IWT 24.12 SG2	<1	<1	<1	0.6 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	<1	
IWT 24.12 SG3	<1	2	<1	<1	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
IWT 24.12 SG4	<1	0.7 J	<1	0.4 J	<1	0.1 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.4 J	
IWT 24.12 SG5	<1	0.6 J	<1	<1	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	0.2 J	<1	<1	<1	
IWT 24.12 SG6	<1	0.3 J	<1	0.8 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.2 J	
IWT 24.12 SG7	<1	0.6 J	<1	<1	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
IWT 24.12 SG8	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J	
IWT 24.12 SG59*	<1	0.8 J	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J	
IWT 24.12 SG9	<1	0.9 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.4 J	
IWT 24.12 SG10	<1	0.7 J	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
IWT 24.12 SG11	<1	0.3 J	<1	<1	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	0.2 J	<1	<1	0.5 J	
IWT 24.12 SG12	<1	0.4 J	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.6 J	

450RBVAU4013G5RST2.WK3

459RBA U/01/SGSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.27 Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.12, Secondary Clarifier
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth					Background Range ¹
	I24.12SB1 9.0-14.0 ft.	I24.12SB1 17.0-18.0 ft.	I24.12SB2 8.0-9.5 ft.	I24.12SB2 14.5-16.0 ft.	I24.12SB3 4.0-6.0 ft.	I24.12SB3 14.0-16.0 ft.
Volatile organic compounds (µg/kg):						
Acetone	ND	61 (J6) 16 (J1)	58 (J6) 15 (J1)	54 (J6) 11 (J1)	29 (J6) 11 (J1)	42 (J6) 12 (J1)
Methylene chloride	ND	ND	ND	ND	33	ND
Tetrachloroethene (PCE)	ND	ND	1.7 (J5)	1.3 (J5)	1.4 (J5)	1.9 (J5)
Toluene	ND	ND				
Semivolatile organic compounds (µg/kg):						
Acenaphthene	ND	ND	ND	ND	ND	ND
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	41 (J1)†	64 (J1)†	ND	61 (J1)†	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND
Metals (mg/kg):						
Arsenic	2.74	5.87	ND	2.36	1.65	7.72
Barium	920	733	324	440	229	827
Cadmium	3.81	0.7	ND	ND	ND	ND
Chromium, total	14.8	10.3	6.27	8.98	9.33	9.27
Lead	5.72	4.58	3.71	2.36	5.6	8.91
Nickel	12.9	6.92	9.05	6.62	8.24	10.1
Zinc	18.2	10.1	10.6	10	10.4	12.7

Table 4.27 continued

Chemical	Sample Identification and Depth						Background Range ¹
	I24.12SB4 6.5-8.0 ft.	I24.12SB4D ² 6.5-8.0 ft.	I24.12SB4 12.5-14.0 ft.	I24.12SB5 6.0-7.5 ft.	I24.12SB6 8.0-8.5 ft.	I24.12SB6 15.0-16.0 ft.	
Volatile organic compounds (µg/kg):							
Acetone	37	32	92	35 (J ₄)	ND	12 (J ₁)	NA
Methylene chloride	11 (J ₁)	9.3 (J ₁)	12 (J ₁)	6.1 (J ₄)	2.5 (J ₁)	3.8 (J ₁)	NA
Tetrachloroethene (PCE)	ND	ND	ND	ND	ND	1.3 (J ₅)	NA
Toluene	ND	ND (J ₅)	1.7	1.6 (J ₆)	ND	ND	NA
Semivolatile organic compounds (µg/kg):							
Acenaphthene	ND	ND	ND	ND	40 (J ₄)	ND	NA
di-n-Butylphthalate	51.3 (J ₁)	104 (J ₁)	87.9 (J ₁)	ND	52 (J ₅)	ND	NA
4-Chloro-3-methylphenol	ND	ND	ND	297 (J ₁)	59 (J ₄)	ND	NA
2-Chlorophenol	ND	ND	ND	320 (J ₁)	43 (J ₄)	ND	NA
bis(2-Ethylhexyl)phthalate	61.9 (J ₁)†	ND	74.5 (J ₁)†	ND	100 (J ₁)	62 (J ₁)†	NA
4-Nitrophenol	ND	ND	ND	233 (J ₆)	ND	ND	NA
Pentachlorophenol	ND	ND	ND	216 (J ₁)	39 (J ₄)	ND	NA
Phenol	ND	ND	ND	348 (J ₁)	ND	ND	NA
Pyrene	ND	ND	ND	ND	42 (J ₄)	ND	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	NA
Metals (mg/kg):							
Arsenic	1.74	ND	2.11	2.35	4.61	1.42	2-11
Barium	270	355	235	534 (J ₆)	308	49.6	47-570
Cadmium	ND	ND	ND	ND	0.44	ND	<2.0
Chromium, total	10.2	6.87	10.4	78.8 (J ₆)	15.9	5.09	6-74

Table 4.27 continued

Chemical	Sample Identification and Depth					Background Range ¹
	I24.12SB4 6.5-8.0 ft.	I24.12SB4D ² 6.5-8.0 ft.	I24.12SB4 12.5-14.0 ft.	I24.12SB5 6.0-7.5 ft.	I24.12SB6 8.0-8.5 ft.	I24.12SB6 15.0-16.0 ft.
Metals, cont.						
Lead	3.8	2.91	1.64	3.14	4.84 (J ₄)	0.83 (J ₄)
Nickel	8.15	8.62	7.02	79.8 (J ₄)	9.34	5.09
Zinc	12.5	10.7	10.6	10.8 (J ₄)	14.3	5.8

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

² I24.12SB4D (6.5-8.0 ft.) is a replicate of I24.12SB4 (6.5-8.0 ft.).

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

four soil borings (SB2, SB3, SB4, and SB5) at concentrations ranging from 1.3 and 1.9 $\mu\text{g}/\text{kg}$. Several SVOCs were detected in SB6 (8.0-8.5') at concentrations ranging from 39 to 100 $\mu\text{g}/\text{kg}$. In addition, most of the soil boring samples contained bis(2-ethylhexyl)phthalate up to a maximum concentration of 100 $\mu\text{g}/\text{kg}$. Di-n-butylphthalate was detected in SB4 at a concentration of 51.3 to 104 $\mu\text{g}/\text{kg}$.

Barium was found in soil borings SB1 and SB3 at concentrations from 733 mg/kg to 920 mg/kg, above the background concentrations range (47-570 mg/kg). Cadmium was detected above the background level (< 2 mg/kg) in SB1 (9-14'), where it was found at a concentration of 3.81 mg/kg. Total chromium was detected at 78.8 mg/kg in SB5 (6.0-7.5'), above the upper background concentration of 74 mg/kg. Also in SB5 (6.0-7.5'), nickel was found at 79.8 mg/kg, above the upper background concentration of 32 mg/kg.

4.3.13 Industrial Sludge Drying Beds (SWMU 24.19)

At this SWMU, thirty soil gas samples and four surface soil samples were collected. Ten soil borings were drilled and twenty-one samples were collected.

Soil Gas. The highest concentrations of all target VOCs were detected at SWMU 24.19. Table 4.28 presents the analytical results. Sample SG25 had five of the eleven highest concentrations: 43,000 ppmv 1,1-DCE, 20,000 ppmv 1,1,1-TCA/1,2-DCE, 1,600 ppmv 1,2-DCA, 11,000 ppmv TCE, and 146,000 ppmv PCE. Vinyl chloride concentrations ranged from 1 ppmv at SG19 to a maximum concentration of 12,000 ppmv at SG3. BTEX was primarily found in samples SG7, SG8, SG9, and SG10. The highest concentrations of ethylbenzene (260 ppmv) and o-xylene (140 ppmv) were found in SG8. Sample SG10 had the highest concentration of benzene (930 ppmv). The highest concentration of 1,1-DCA (220 ppmv) was detected in SG9 and SG14; the lowest concentration (3 ppmv) was detected in SG22 and SG28. It therefore appears that the highest concentrations of VOCs are on the east and west side of the SWMU.

Surface Soil. Acetone, PCE, and TCE were the only VOCs found in the surface soil samples (Table 4.29). Acetone was detected in SS1 (42 $\mu\text{g}/\text{kg}$). PCE was detected in SS2 and SS4, and TCE was detected in SS4 at concentrations below the quantitation limit. As shown in Table 4.29, PCBs were detected at all four sampling locations. The maximum concentration was at SS4 (467 $\mu\text{g}/\text{kg}$).

Bis(2-ethylhexyl)phthalate was detected in all four samples. It was also detected in the method blank; therefore, the concentrations are estimated. Di-n-butylphthalate was detected in SS2 at a concentration below the quantitation limit.

Arsenic and selenium were not found in the surface soil samples. Barium levels were within the background range. Cadmium levels were very elevated compared to background (< 2 mg/kg) ranging from 2.89 mg/kg in SS3 to 60.6 mg/kg in SS1. Chromium levels were also very high, ranging from 78.6 to 2,650 mg/kg, well above the background range of 6-74 mg/kg. Lead concentrations in all four samples varied from 13.4 mg/kg in SS3 to 215 mg/kg in SS4, background range is 4-48 mg/kg. Mercury was not detected in two of the four samples (SS2 and SS4) but was detected in SS1 and SS3. Elevated concentrations of nickel were detected ranging

Table 4.28
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 24.19, Industrial Sludge Drying Beds
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/							TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)								
IWT24.19 SG1	<1	0.4 J	<1	<1	<1	0.6 J	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.19 SG2	<1	3	<1	15	<1	25	<1	<1	<1	<1	<1	<1	<1	1
IWT24.19 SG3	12000	<1	<1	11000	<1	300	<1	<1	<1	<1	<1	<1	<1	900
IWT24.19 SG4	3100	<1	<1	1300	<1	540	24	<1	25	<1	<1	<1	<1	1300
IWT24.19 SG5	30	<1	<1	6	<1	2	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.19 SG6	34	<1	<1	45	<1	200	12	<1	<1	<1	<1	2	<1	35
IWT24.19 SG54*	140	<1	<1	100	<1	480	51	<1	50	100	100	38	17	400
IWT24.19 SG7	58	<1	<1	100	0.4 J	<1	6	<1	21	56	56	46	25	56
IWT24.19 SG8	1100	<1	<1	590	85	<1	80	<1	140	290	290	260	140	<1
IWT24.19 SG9	160	240	220	1300	180	<1	38	<1	3	85	85	8	13	190
IWT24.19 SG10	130	350	190	830	930	<1	1800	<1	12	590	590	180	69	<1
IWT24.19 SG11	16	82	25	850	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.19 SG12	320	260	67	2700	<1	27	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.19 SG13	<1	0.4 J	<1	0.9 J	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1
IWT24.19 SG14	1500	280	220	840	<1	130	17	<1	<1	<1	<1	6	7	480
IWT24.19 SG15	8	6	<1	1	<1	0.5 J	<1	<1	<1	27	27	<1	<1	9
IWT24.19 SG16	<1	0.5 J	<1	0.3 J	<1	<1	<1	<1	<1	0.2 J	0.2 J	<1	<1	0.5 J
IWT24.19 SG17	50	11000	<1	16000	<1	240	<1	<1	<1	54000	54000	<1	<1	83000
IWT24.19 SG18	10	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J	0.3 J	<1	<1	1
IWT24.19 SG19	1	48	0.3 J	40	<1	10	<1	<1	0.1	340	340	<1	<1	140
IWT24.19 SG20	10	1	<1	2	<1	2	<1	<1	<1	23	23	<1	<1	68
IWT24.19 SG21	6	59	<1	3	<1	4	2	<1	2	3	3	<1	<1	23
IWT24.19 SG22	1	26	6	15	<1	3	3	<1	0.2 J	5	5	<1	<1	31
IWT24.19 SG23	120	1300	51	820	<1	150	270	<1	260	6200	6200	<1	<1	4000
IWT24.19 SG24	120	720	61	800	<1	380	380	<1	4	4500	4500	<1	<1	14000
IWT24.19 SG25	750	43000	44	20000	<1	1600	11000	<1	<1	*****	*****	<1	<1	81000
IWT24.19 SG69*	44	730	91	960	<1	260	170	<1	<1	2400	2400	3	<1	4300
IWT24.19 SG26	130	250	25	200	<1	120	200	<1	3	520	520	<1	<1	930
IWT24.19 SG27	110	56	43	350	<1	85	26	<1	<1	3	3	2	1	250
IWT24.19 SG28	7	34	3	11	<1	14	19	<1	0.1 J	12	12	<1	<1	110
IWT24.19 SG29	5	8	0.2 J	4	<1	0.5 J	2	<1	1 J	6	6	<1	<1	12
IWT24.19 SG30	<1	0.8 J	<1	0.4 J	<1	<1	<1	<1	0.1 J	0.5 J	0.5 J	<1	<1	1

50R B\A\U401\SGSR\ST2.WK

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

450R\B\A\U401\SGSR\ST2.WK3

Table 4.29
Chemical Constituents Detected in Soils, October and November 1993
SWMU 24.19 Industrial Sludge Drying Beds
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth										Background Range ²
	I24.19SS1* 0.17-0.33 ft.	I24.19SS2* 0.17-0.33 ft.	I24.19SS3* 0.17-0.33 ft.	I24.19SS4* 0.17-0.5 ft.	I24.19SB1 5.0-6.0 ft.	I24.19SB1D ¹ 5.0-6.0 ft.	I24.19SB1 16.0-17.0 ft.	I24.19SB2 7.5-8.0 ft.	I24.19SB2 17.0-17.5 ft.		
Volatile organic compounds (µg/kg):											
Acetone	42 (J ₄)	ND	ND	ND	89 (J ₄)	140 (J ₄)	120 (J ₄)	14 (J ₁)	20 (J ₁)	NA	
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	160	ND	NA	
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Methylene chloride	ND	ND	ND	ND	12 (J ₄)	12 (J ₄)	12 (J ₄)	10	ND	NA	
Tetrachloroethene (PCE)	ND	1.4 (J ₅)	ND	3.4 (J ₅)	ND	ND	ND	ND	ND	NA	
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Trichloroethene (TCE)	ND	ND	ND	2.8 (J ₅)	ND	ND	ND	ND	ND	NA	
Xylene (total)	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Semivolatile organic compounds (µg/kg):											
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
di-n-Butylphthalate	ND	90.6 (J ₅)	ND	ND	ND	ND	ND	ND	ND	NA	
4-Chloro-3-methylphenol	ND	ND	ND	ND	311 (J ₆)	319 (J ₆)	321 (J ₆)	ND	ND	NA	
2-Chlorophenol	ND	ND	ND	ND	270 (J ₆)	268 (J ₆)	306 (J ₆)	ND	ND	NA	
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	299 (J ₁)	197 (J ₁)	611 (J ₁)	514 (J ₁)	ND	56.3 (J ₆)†	44.9 (J ₆)†	160 (J ₅)	116 (J ₅)	NA	
4-Nitrophenol	ND	ND	ND	ND	370 (J ₆)	385 (J ₆)	348 (J ₆)	ND	ND	NA	
Pentachlorophenol	ND	ND	ND	ND	283 (J ₆)	277 (J ₆)	226 (J ₆)	ND	ND	NA	
Phenol	ND	ND	ND	ND	295 (J ₆)	304 (J ₆)	355 (J ₆)	ND	ND	NA	
Cyanide (mg/kg)	5.15 (J ₆)	0.88 (J ₆)	ND	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg):											
Arochlor 1254	197	ND	ND	ND	NA	NA	NA	NA	NA	NA	
Arochlor 1260	ND	124	41 (J ₄)	467	NA	NA	NA	NA	NA	NA	
Metals (mg/kg):											
Arsenic	ND	ND	ND	ND	2.69	2.83	1.85	2.39	1.65	2-11	
Barium	263 (J ₆)	196 (J ₆)	538 (J ₆)	222 (J ₆)	609	616	67.1	823	72.9	47-570	
Cadmium	60.6 (J ₆)	15.5 (J ₆)	2.89 (J ₆)	3.64 (J ₆)	ND	ND	ND	ND	ND	<2.0	
Chromium, total	2650 (J ₄)	473 (J ₄)	78.6 (J ₄)	86.5 (J ₄)	553 (R)	60.5 (R)	10.4 (R)	15.3	5.97	6-74	
Lead	142 (J ₄)	25.3 (J ₄)	13.4 (J ₄)	215 (J ₄)	7.95	7.07	5.1	6.15	2.03	<4-48	
Mercury	0.21	ND	0.11	ND	ND	ND	ND	ND	ND	NA	
Nickel	312 (J ₄)	523 (J ₄)	562 (J ₄)	304 (J ₄)	13.3	13.9	5.68	12.1	3.18	6-32	
Selenium	ND	ND	ND	ND	0.58	0.59	0.58	ND	ND	<0.1-0.2	
Silver	16.6 (J ₄)	11.5 (J ₄)	2.14 (J ₄)	5.56 (J ₄)	0.12	0.12	ND	ND	ND	<2.0	
Zinc	55.8 (J ₄)	39.3 (J ₄)	24.9 (J ₄)	51.6 (J ₄)	19.3	19.4	4.64	17.4	4.45	5-53	

Table 4.29 continued

Chemical	Sample Identification and Depth								Background Range ²
	I24.19SB3 5.5-6.5 ft.	I24.19SB3 17.5-18.0 ft.	I24.19SB4 8.5-9.0 ft.	I24.19SB4 16.0-17.0 ft.	I24.19SB5 7.5-8.0 ft.	I24.19SB5 15.5-16.0 ft.	I24.19SB6 6.5-7.0 ft.	I24.19SB6 15.5-16.0 ft.	
Volatile organic compounds (µg/kg):									
Acetone	160 (J ₆)	ND	ND	ND	53 (J ₁)	220 (J ₁)	ND	ND	NA
2-Butanone (MEK)	21	ND	ND	ND	ND	ND	ND	ND	NA
Chlorobenzene	ND	ND	ND	ND	ND	21	ND	ND	NA
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	NA
1,2-Dichloroethene	19	ND	ND	ND	ND	19	ND	ND	NA
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	NA
Methylene chloride	6	ND	ND	ND	ND	8.3	ND	ND	NA
Tetrachloroethene (PCE)	ND	ND	ND	ND	ND	ND	ND	ND	NA
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	NA
Trichloroethene (TCE)	ND	ND	ND	ND	ND	ND	ND	ND	NA
Xylene (total)	ND	ND	ND	ND	ND	ND	ND	ND	NA
Semivolatile organic compounds (µg/kg):									
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	NA
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA
bis(2-Ethylhexyl)phthalate	180 (J ₁)	200 (J ₁)	150 (J ₁)	110 (J ₁)	248 (J ₅)	110 (J ₅)	62 (J ₁)†	110 (J ₁)	NA
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA
PCBs (µg/kg):									
Arochlor 1254	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arochlor 1260	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals (mg/kg):									
Arsenic	3	1.58	2.29	2.14	2.97	4.25	2.61	1.98	2-11
Barium	419	46.2	365	301	230	703	394	458	47-570
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Chromium, total	14.9 (J ₆)	17.2 (J ₆)	12 (J ₆)	10.3 (J ₆)	13.6	13.8	11.4 (J ₆)	8.04 (J ₆)	6-74
Lead	7.97	1.21	6.99	6.06	7.66	10.2	6.81	4.89	<4-48
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA
Nickel	22.7 (J ₄)	5.7 (J ₄)	10.1 (J ₄)	10.1 (J ₄)	9.72	15.7	10.4 (J ₄)	8.5 (J ₄)	6-32
Selenium	ND	0.85	ND	0.71	0.69	ND	0.68	ND	<0.1-0.2
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Zinc	23	5.94	21.4	17.5	20.1	18.1	15.6	11.8	5-53

Table 4.29 continued

Chemical	Sample Identification and Depth										Background Range ²
	I24.19SB7 6.5-7.5 ft.	I24.19SB7 17.0-18.0 ft.	I24.19SB8 6.0-7.0 ft.	I24.19SB8 17.0-17.5 ft.	I24.19SB9 7.5-8.0 ft.	I24.19SB9 17.0-18.0 ft.	I24.19SB10 5.0-6.0 ft.	I24.19SB10 17.0-18.0 ft.			
Volatile organic compounds (µg/kg):											
Acetone	50 (J ₁)	17 (J ₁)	ND	16 (J ₁)	77 (J ₄)	100 (J ₄)	69 (J ₄)	98 (J ₄)	NA	NA	
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
1,1-Dichloroethane	ND	ND	ND	ND	51 (J ₄)	ND	ND	ND	NA	NA	
1,2-Dichloroethene	47	ND	ND	12	1200 (J ₆)	7.7 (J ₄)	ND	ND	NA	NA	
1,2-Dichloropropane	ND	ND	ND	ND	32 (J ₄)	ND	ND	ND	NA	NA	
Methylene chloride	12	ND	ND	ND	ND	ND	12 (J ₄)	9.2 (J ₄)	NA	NA	
Tetrachloroethene (PCE)	68	ND	ND	6.2	ND	ND	ND	ND	NA	NA	
Toluene	ND	ND	ND	ND	ND	ND	7.4 (J ₆)	ND	NA	NA	
Trichloroethene (TCE)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
Xylene (total)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
Semivolatile organic compounds (µg/kg):											
Benzoic acid	71 (J ₅)	52 (J ₅)†	ND	51.2 (J ₅)†	ND	ND	ND	ND	NA	NA	
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
4-Chloro-3-methylphenol	ND	ND	ND	ND	320 (J ₆)	332 (J ₆)	317 (J ₆)	317 (J ₆)	NA	NA	
2-Chlorophenol	ND	ND	ND	ND	307 (J ₆)	300 (J ₆)	310 (J ₆)	298 (J ₆)	NA	NA	
Diethylphthalate	82.8 (J ₅)	84.7 (J ₅)	86.7 (J ₅)	ND	ND	ND	ND	ND	NA	NA	
bis(2-Ethylhexyl)phthalate	72.3 (J ₅)†	102 (J ₅)	144 (J ₅)	97.1 (J ₅)	39.1 (J ₆)†	ND	ND	ND	NA	NA	
4-Nitrophenol	ND	ND	ND	ND	334 (J ₆)	317 (J ₆)	309 (J ₆)	280 (J ₆)	NA	NA	
Pentachlorophenol	ND	ND	ND	ND	222 (J ₆)†	233 (J ₆)†	204 (J ₆)†	176 (J ₆)†	NA	NA	
Phenol	ND	ND	ND	ND	375 (J ₆)	345 (J ₆)	359 (J ₆)	344 (J ₆)	NA	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
PCBs (µg/kg):											
Arochlor 1254	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Arochlor 1260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Table 4.29 continued

Chemical	Sample Identification and Depth								Background Range ²
	I24.19SB7 6.5-7.5 ft.	I24.19SB7 17.0-18.0 ft.	I24.19SB8 6.0-7.0 ft.	I24.19SB8 17.0-17.5 ft.	I24.19SB9 7.5-8.0 ft.	I24.19SB9 17.0-18.0 ft.	I24.19SB10 5.0-6.0 ft.	I24.19SB10 17.0-18.0 ft.	
Metals (mg/kg):									
Arsenic	2.5	ND	2.03	2.32	3.1	3.4	2.93	ND	2-11
Barium	430	58	204	482	234	558	275	93.5	47-570
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Chromium, total	13.5	0.778	7.57	10.1	10.2 (R)	15.6 (R)	14.9 (R)	3.39 (R)	6-74
Lead	6.69	0.415	6.33	5.11	9.87	7.75	7.62	0.90	<4-48
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA
Nickel	9.98	ND	6.89	11	7.8	12.8	10.2	3.84	6-32
Selenium	ND	ND	ND	ND	ND	ND	0.59	ND	<0.1-0.2
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Zinc	14.6	ND	11.6	14	14.1	17.5	17.2	2.83	5-53

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not analyzed/not applicable

¹ I24.19SB1D (5.0-6.0 ft.) is a replicate of I24.19SB1 (5.0-6.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

R QC criteria outside control limits. Data are unusable for all purposes.

from 304 to 562 mg/kg, significantly above the background concentration range of 6-32 mg/kg. Silver concentrations were also elevated in all samples compared to the background concentration range. Cyanide was detected in SS1 and SS2 at 5.15 mg/kg and 0.88 mg/kg, respectively.

Soil Borings. A total of ten soil borings (SB1 through SB10) were sampled at this SWMU (Table 4.29). Acetone was found in all soil borings except for SB3, SB4, and SB6. The highest concentration of acetone was 220 $\mu\text{g/kg}$ in SB5 (15.5-16'). Methylene chloride was found at low levels (8.3 to 12 $\mu\text{g/kg}$) in five soil borings: SB1, SB2, SB5, SB7, and SB10. The compound 1,2-DCE was also detected in five soil borings ranging from 7.7 $\mu\text{g/kg}$ in SB19 (17 to 18') to 1,200 $\mu\text{g/kg}$ in SB19 (7.5 to 8'). PCE was found only in two samples: SB7 (6.5 to 7.5') and SB8 (17 to 17.5'), at 68 $\mu\text{g/kg}$ and 6.2 $\mu\text{g/kg}$, respectively. The SVOC bis(2-ethylhexyl)phthalate was detected in every soil boring except SB10. The concentrations ranged from 39.1 $\mu\text{g/kg}$ (SB9, 7.5 to 8') to 248 $\mu\text{g/kg}$ (SB5, 7.5 to 8'). Five phenolic compounds were detected in samples from SB1, SB9, and SB10. The concentrations of the phenolic compounds are consistent with laboratory spiking concentrations and were reported by the laboratory as contaminants of a spiking solution.

Barium was detected in SB1, SB2, and SB5 at concentrations above the upper background range. cadmium was not detected in any of the subsurface soil samples. All other metals were detected at concentrations within their respective background ranges.

4.3.14 Recirculation Pit (RCP)

Ten soil gas samples and one surface soil sample were collected. Three soil borings were drilled at this unit and six samples were collected.

Soil Gas. Table 4.30 presents the soil gas analytical results for the recirculation pit. All eleven target VOCs were detected in samples from this SWMU. Shallow water was encountered at the location of SG4. A water sample was collected, and the headspace was analyzed.

Most compounds were detected at concentrations below the quantitation limit of 1 ppmv. Sample SG1 contained relatively high concentrations of 1,1-DCA (39 ppmv), 1,1,1-TCA/1,2-DCE (79 ppmv), and 1,2-DCA (190 ppmv). Vinyl chloride was detected in five samples at concentrations ranging from 1 to 9 ppmv. The headspace sample contained concentrations of all target VOCs except vinyl chloride, 1,1-DCE, and PCE.

Surface Soil. Only one surface soil sample was collected at this SWMU for analysis (Table 4.31). PCE (2.9 $\mu\text{g/kg}$) was the only VOC detected. Diethylphthate (266 $\mu\text{g/kg}$), bis(2-ethylhexyl)phthalate (1,480 $\mu\text{g/kg}$), and di-n-octylphthalate (110 $\mu\text{g/kg}$) were all found in SS1. Other SVOCs detected in this sample were 2-methylnaphthalene (1,010 $\mu\text{g/kg}$) and p-cresol (8,120 $\mu\text{g/kg}$). Elevated concentrations of two petroleum hydrocarbon groups were found in SS1. The gasoline component concentration was 70,000 $\mu\text{g/kg}$; kerosene type compounds (C9-C18) were found at a concentration of 3,100 mg/kg.

Table 4.30
Chemical Constituents Detected in Soil Gas, September and October 1993
Recirculation Pit
Tinker AFB, Oklahoma

Sample	1,1,1-TCA/ Vinyl Chloride												Unknowns (ppmv)
	Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)		
RCP1 SG1	<1	0.4 J	39	79	0.9 J	190	9	3	<1	0.2 J	0.2 J	15	
RCP1 SG2	<1	32	4	5	<1	9	0.4 J	0.3 J	<1	<1	<1	<1	
RCP1 SG3	<1	<1	<1	6	<1	9	0.8 J	0.5 J	<1	0.3 J	0.3 J	2	
RCP1 SG4*	<1	<1	36	20	8	140	28	13	<1	9	4	110	
RCP1 SG5	9	0.4 J	<1	2	<1	0.3 J	<1	0.1 J	0.1 J	<1	<1	1	
RCP1 SG6	3	9	<1	<1	<1	<1	<1	0.2 J	<1	<1	<1	4	
RCP1 SG7	1	2	<1	0.5 J	<1	0.4 J	0.1 J	0.1 J	<1	<1	<1	4	
RCP1 SG8	2	4	<1	0.6 J	<1	0.1 J	0.1 J	0.1 J	<1	<1	<1	2	
RCP1 SG9	<1	3	<1	1	<1	0.2 J	<1	<1	0.2 J	<1	<1	0.6 J	
RCP1 SG10	1	3	<1	0.5 J	<1	<1	<1	<1	0.3 J	<1	<1	1 J	

459RBAU401SGSRST2.WK3

450REIAU401\SGSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Headspace sample.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.31
Chemical Constituents Detected in Soils, October and November 1993
Recirculation Pit
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth						Background Range ¹
	RCPSS1* 0.17-0.33 ft.	RCPSB1 6.0-8.0 ft.	RCPSB2 4.0-6.0 ft.	RCPSB2 6.0-8.0 ft.	RCPSB3 0.0-1.5 ft.	RCPSB3 4.0-6.0 ft.	
Volatile organic compounds (µg/kg):							
Acetone	ND	670 (J6)	530 (J4)	150 (J4)	6600 (J4)	220 (J4)	NA
Benzene	ND	ND	32	ND	ND	ND	NA
2-Butanone (MEK)	ND	ND	ND	14	4500	14	NA
Chlorobenzene	ND	6700 (J6)	420	ND	280 (J5)	ND	NA
Chloroform	ND	160 (J6)	ND	ND	ND	ND	NA
Ethyl benzene	ND	7400 (J6)	130	ND	2100	1.5 (J5)	NA
Methylene chloride	ND	ND	ND	ND	190 (J4)	ND	NA
4-Methyl-2-pentanone	ND	ND	ND	ND	2400	ND	NA
Tetrachloroethene (PCE)	2.9 (J5)	ND	ND	ND	ND	ND	NA
Toluene	ND	1200 (J6)	55 (J6)	ND	24000 (J6)	ND	NA
1,1,1-Trichloroethane (TCA)	ND	260 (J6)	ND	ND	ND	ND	NA
Xylene (total)	ND	8200 (J4)	400	ND	13000	23	NA
Semivolatile organic compounds (µg/kg):							
4-Chloro-3-methylphenol	ND	ND	359 (J1)	244 (J1)	ND	127 (J1)	NA
2-Chlorophenol	ND	ND	305 (J1)	350 (J1)	ND	130 (J1)	NA
Dibenzofuran	ND	1030 (J6)	ND	ND	ND	ND	NA
1,2-Dichlorobenzene	ND	ND	ND	ND	625 (J5)	ND	NA
Diethylphthalate	266 (J5)	ND	ND	ND	ND	ND	NA
bis(2-Ethylhexyl)phthalate	1480 (J1)	2130 (J6)	581 (J1)	67 (J1)†	2470 (J1)	185 (J1)	NA
Fluoranthene	ND	ND	ND	ND	ND	44 (J5)	NA
2-Methylnaphthalene	1010	24500 (J6)	612 (J5)	ND	3910	225 (J5)	NA
2-Methylphenol (o-cresol)	ND	ND	ND	ND	1170 (J5)	ND	NA
4-Methylphenol (p-cresol)	8120	ND	ND	ND	ND	ND	NA
Napthalene	ND	19000 (J6)	ND	ND	1450 (J5)	59 (J5)	NA
4-Nitrophenol	ND	ND	ND	354 (J1)	ND	77 (J6)	NA
di-n-Octylphthalate	110 (J5)†	ND	ND	ND	ND	ND	NA
Pentachlorophenol	ND	ND	ND	95 (J1)†	ND	120 (J1)†	NA
Phenol	ND	912 (J6)	397 (J1)	320 (J1)	ND	165 (J1)	NA
Cyanide (mg/kg)	1.66 (J6)	0.59	ND	ND	0.968	0.909	NA

Table 4.31, cont.

Chemical	Sample Identification and Depth						Background Range ¹
	RCPSS1* 0.17-0.33 ft.	RCPSB1 6.0-8.0 ft.	RCPSB2 4.0-6.0 ft.	RCPSB2 6.0-8.0 ft.	RCPSB3 0.0-1.5 ft.	RCPSB3 4.0-6.0 ft.	
PCBs (µg/kg)	ND	NA	NA	NA	NA	NA	NA
Total petroleum hydrocarbons:							
Gasoline components (µg/kg)	70000	171000	50.6	9.5	26300	2640	NA
Kerosene C9-C18 (mg/kg)	3100	2880 (J4)	ND	ND	994	ND	NA
Miscellaneous C7-C20 (mg/kg)	ND	ND	NA	NA	ND	10.8	NA
Miscellaneous C8-C20 (mg/kg)	ND	ND	22	NA	ND	NA	NA
Miscellaneous C9-C16 (mg/kg)	ND	ND	ND	4.17	ND	NA	NA
Metals (mg/kg):							
Arsenic	1.3	2.09	3.31	3.01	2.31	1.68	2-11
Barium	273 (J6)	334	632 (J6)	349 (J6)	334 (J6)	594 (J6)	47-570
Cadmium	62.8 (J6)	13.8 (J4)	ND	ND	11.1	2.15	<2.0
Chromium, total	239 (J4)	343 (R)	21.8 (J4)	53.6 (J4)	74.9 (J4)	76.9 (J4)	6-74
Lead	98.6 (J4)	19.8	8.71	10.2	40.6	8.62	<4-48
Mercury	0.13	0.19	ND	ND	0.16 (J4)	ND	NA
Nickel	123 (J4)	172	13.1 (J4)	21 (J4)	39.9 (J4)	23.6 (J4)	6-32
Selenium	ND	ND	0.74	ND	ND	ND	<0.1-0.2
Silver	7.56 (J4)	2.21	ND	ND	1.5	0.84	<2.0
Zinc	90.9 (J4)	39.2	18 (J4)	23.4 (J4)	22.1 (J4)	16.4 (J4)	5-53

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

1 Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J1 Blank contamination. Indicates possible high bias and/or false positives.

J2 Calibration range exceeded. Indicates possible low bias.

J3 Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J4 Other QC criteria outside control limits. Bias not readily determined.

J5 Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J6 Data is qualified with two or more of the above qualifiers.

Nine metals were detected in surface soils at this site. All were above background concentration ranges except arsenic, barium, and selenium. Selenium was the only metal not detected in the surface soil sample. Cadmium, chromium, lead, nickel, and zinc were all found at levels considerably greater than their respective upper background range concentrations. Cyanide was detected in SS1 (1.66 mg/kg). No PCBs were detected.

Soil Borings. Three soil borings (SB1, SB2, and SB3) were sampled at this location (Table 4.31). In these borings, several VOCs and SVOCs were detected at relatively high concentrations. In SB3 (0-1.5') elevated concentrations of acetone (6,600 µg/kg), ethylbenzene (2,100 µg/kg), total xylene (13,000 µg/kg), methyl ethyl ketone (4,500 µg/kg), and methylene chloride (190 µg/kg) were detected. Also in SB3 (4.0-6.0'), 4-methyl-2-pentanone and toluene were detected at concentrations of 2,400 µg/kg and 24,000 µg/kg, respectively. The highest concentrations of chlorobenzene (420 µg/kg) and benzene (32 µg/kg) were found in SB2 from 4.0 to 6.0 feet bgs. Bis(2-ethylhexyl)phthalate was detected in all three soil borings at concentrations ranging from 67 to 2,470 µg/kg. In addition to bis(2-ethylhexyl)phthalate, several other SVOCs were detected at elevated concentrations, including 2-methylnaphthalene, six variations of phenol, 1,2-dichlorobenzene, and naphthalene. The SVOC 2-methylnaphthalene was detected at a maximum concentration of 3,910 µg/kg in SB3 (0-1.5'). The phenols were detected at concentrations ranging from 77 to 1,170 µg/kg. The maximum phenol concentration (1,170 µg/kg) was 2-methylphenol (o-cresol), detected in SB3 from 0 to 1.5 feet bgs. SB3 (0-1.5') also contained 1,2-dichlorobenzene and naphthalene at concentrations of 625 µg/kg and 1,450 µg/kg, respectively.

Cyanide was detected in SB3 (0-1.5' and 4.0-6.0') at concentrations ranging from 0.909 to 0.968 µg/kg. Soil samples at the RCP were also analyzed for TPH. Gasoline components were found in all soil borings up to a maximum concentration of 26,300 µg/kg in SB3 (0-1.5'). Kerosene C9-C18 was also found in SB3 (0-1.5') at a concentration of 994 mg/kg. Miscellaneous kerosenes C8-C20, C8-C16, and C7-C20 were found at concentrations ranging from 4.17 to 22 mg/kg.

The concentrations of arsenic ranged from 1.68 to 3.31 mg/kg. Elevated levels of barium were detected in soil borings SB2 and SB3 with concentrations at from 632 mg/kg and 594 mg/kg, respectively. Cadmium levels were very high in SB1 and SB3 (13.8 and 11.1 mg/kg, respectively), well above the background level of <2 mg/kg. Total chromium concentrations, ranging from 53.6 to 76.9 mg/kg, were found in SB2 (6.0-8.0') and SB3 (0-1.5' and 4.0-6.0'). Nickel was detected in SB3 at concentrations ranging from 23.6 to 39.9 mg/kg. Selenium was detected in SB2 (4.0-6.0') at a concentration of 0.74 mg/kg. Silver was detected in SB3 at concentrations ranging from 0.84 to 1.5 mg/kg.

4.3.15 Parshall Flume (SWMU 32.1)

At this SWMU, four soil gas samples and one surface soil sample were collected. Three soil borings were drilled and eight samples were collected.

Soil Gas. The soil gas analytical results are presented in Table 4.32. DCE was the only compound detected, and was found in all three samples at concentrations

Table 4.32
 Chemical Constituents Detected in Soil Gas, September and October 1993
 SWMU 32.1, Marshall Flume
 Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/ 1,1-DCE				Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	1,2-DCA (ppmv)								
SWT 32.1 SG1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.1 SG2	<1	0.7 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.1 SG3	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

450RBAU(01)SOSB2T2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
 DCE = dichloroethene PCE = tetrachloroethene
 TCA = trichloroethane ppmv = parts per million vapor

of 0.7 ppmv (SG2), 1 ppmv (SG1), and 3 ppmv (SG3). A sample was not collected at S32.1SG4 because subsurface conditions prevented the probe from being driven more than 18 inches into the ground.

Surface Soil. Table 4.33 presents the analytical results of the surface soil and soil boring samples. Chloroform, methylene chloride, and PCE were the only VOCs detected in the surface soil sample collected.

Ten SVOCs were detected in the surface soil sample. Two phthalates, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, were found at 220 $\mu\text{g/kg}$ and 79.3 $\mu\text{g/kg}$, respectively. The remaining compounds detected in SS1 were polyaromatic hydrocarbons (PAHs), including benzo(b)fluoranthene (77.2 $\mu\text{g/kg}$), chrysene (117 $\mu\text{g/kg}$), and pyrene (184 $\mu\text{g/kg}$).

Cyanide and selenium were not detected in the surface soil sample. The concentration of chromium, 92.4 mg/kg, was above the upper background concentration of 74 mg/kg. The cadmium concentration, 2.76 mg/kg, was also elevated relative to the background level (<2 mg/kg). The remaining metals were found at levels within their respective background concentrations. No PCBs were detected in the surface soil sample.

Soil Borings. Three soil borings (SB1, SB2, and SB3) were sampled at this location (Table 4.33). Acetone and methylene chloride were detected in all three soil borings at concentrations ranging from 19 to 73 $\mu\text{g/kg}$ and 10 to 32 $\mu\text{g/kg}$, respectively. Toluene was detected in SB2 (6.5-8.0' and 16.0-18.0') at a concentration of 1.4 $\mu\text{g/kg}$. Bis(2-ethylhexyl)phthalate was detected in all soil borings at concentrations ranging from 39.7 to 265 $\mu\text{g/kg}$. Benzylbutylphthalate was detected in SB2 (6.5-8.0') at a concentration of 40.7 $\mu\text{g/kg}$. Di-n-butylphthalate was detected in all soil borings up to a maximum concentration of 172 $\mu\text{g/kg}$ in SB2 (6.5-8.0').

Arsenic was detected in all soil borings, reaching a maximum concentration of 3.96 mg/kg. Barium was also detected in all soil borings, reaching a maximum concentration of 470 mg/kg, within the background range. Selenium was detected at a concentration of 0.58 mg/kg in SB2 (6.5-8.0').

4.3.16 Flocculation Chambers (SWMU 32.2)

Three soil gas samples were collected and two soil borings were drilled at this SWMU. Three borings were originally planned; however, SB1 was abandoned because of site constraints. A total of five soil boring samples were collected.

Soil Gas. Analytical results for the soil gas survey at SWMU 32.2 are presented in Table 4.34. Five chlorinated hydrocarbons were detected in the three samples. Maximum concentrations include 5 ppmv vinyl chloride (SG3), 3 ppmv 1,1-DCE (SG2), and 1 ppmv 1,1,1-TCA/1,2-DCE (SG3). The compound 1,1-DCE was detected in all three samples; however, SG1 and SG3 contained levels below the quantitation limit. Trace levels of toluene (SG3) and PCE (SG1) were also detected.

Table 4.33 Chemical Constituents Detected in Soils, October 1993
SWMU 32.1, Marshall Flume
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth										Background Range ²
	S32.1SS1*	S32.1SB1	S32.1SB1	S32.1SB1	S32.1SB1	S32.1SB1D ¹	S32.1SB2	S32.1SB2	S32.1SB3	S32.1SB3	
	0.17-0.33 ft.	5.0-5.5 ft.	8.5-9.0 ft.	14.5-15.5 ft.	14.5-15.5 ft.	14.5-15.5 ft.	6.5-8.0 ft.	16.0-18.0 ft.	8.0-8.5 ft.	17.5-18.0 ft.	
Volatile organic compounds (µg/kg):											
Acetone	ND	56	ND	65	73	46	33	19	24	NA	
Chloroform	1.1 (J ₁)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Methylene chloride	9.1 (J ₄)	32 (J ₁)	28 (J ₁)	24 (J ₁)	24 (J ₁)	11 (J ₁)	10 (J ₁)	19 (J ₁)	13 (J ₁)	NA	
Tetrachloroethene (PCE)	7.9	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Toluene	ND	ND	ND	ND	ND	1.4 (J ₅)	1.4 (J ₅)	ND	ND	NA	
Semivolatile organic compounds (µg/kg):											
Benzo(a)anthracene	78.5 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Benzo(a)pyrene	81 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Benzo(b)fluoranthene	77.2 (J ₅)†	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Benzo(k)fluoranthene	93.5 (J ₅)†	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Butyl benzyl phthalate	ND	ND	ND	ND	ND	40.7 (J ₅)†	ND	ND	ND	NA	
di-n-Butylphthalate	79.3 (J ₅)	ND	77.7 (J ₁)	59.3 (J ₁)	59.2 (J ₁)	172 (J ₁)	115 (J ₁)	44 (J ₁)	47.5 (J ₁)	NA	
Chrysene	117 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	220 (J ₁)	70.8 (J ₁)†	61.7 (J ₁)†	56.8 (J ₁)†	ND	81.4 (J ₁)†	39.7 (J ₁)†	112 (J ₁)	265 (J ₁)	NA	
Fluoranthene	201 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Phenanthrene	90.5 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Pyrene	184 (J ₅)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Table 4.33, cont.

Chemical	Sample Identification and Depth										Background Range ²
	S32.1SS1* 0.17-0.33 ft.	S32.1SB1 5.0-5.5 ft.	S32.1SB1 8.5-9.0 ft.	S32.1SB1 14.5-15.5 ft.	S32.1SB1D ¹ 14.5-15.5 ft.	S32.1SB2 6.5-8.0 ft.	S32.1SB2 16.0-18.0 ft.	S32.1SB3 8.0-8.5 ft.	S32.1SB3 17.5-18.0 ft.		
Metals (mg/kg):											
Arsenic	2.97 (J4)	2.59	2.69	ND	ND	3.74	1.31	3.96	ND	2-11	
Barium	252	430	230	72.4	79.7	215	470	226	53.2	47-570	
Cadmium	2.76	ND	ND	ND	ND	ND	ND	ND	ND	<2.0	
Chromium, total	92.4	33.5 (J4)	19.6 (J4)	7.76 (J4)	9.42 (J4)	13.2 (J4)	7.33 (J4)	26.6 (J4)	8.12 (J4)	6-74	
Lead	25	8.89	7.05	3.28	4.33	6.54	2.3	9.38	2.74	<4-48	
Mercury	0.3	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Nickel	25.6	18.9	15.1	5.9	8.55	8.87	6.46	19.1	7.46	6-32	
Silver	1.91 (J4)	ND	ND	ND	ND	ND	ND	ND	ND	<0.1-0.2	
Selenium	ND	ND	ND	ND	ND	0.58	ND	ND	ND	<2.0	
Zinc	94.1	26.3	19.6	7.11	9.42	18.9	6.68	25.8	8.56	5-53	

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ S32.1SB1D (14.5-15.5 ft.) is a replicate of S32.1SB1 (14.5-15.5 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.34
 Chemical Constituents Detected in Soil Gas, September and October 1993
 SWMU 32.2, Flocculation Chambers
 Tinker AFB, Oklahoma

Sample	1,1,1-TCA/ Vinyl Chloride										Unknowns (ppmv)
	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	1,1-DCE (ppmv)	
SWT 32.2 SG1	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.2 SG2	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.2 SG3	5	0.3 J	<1	1	<1	<1	<1	<1	<1	<1	27

450RBVA U401SGSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
 DCE = dichloroethene PCE = tetrachloroethene
 TCA = trichloroethane ppmv = parts per million vapor

Soil Borings. Two soil borings (SB2 and SB3) were sampled at this location (Table 4.35). Acetone and methylene chloride were detected in both soil borings at concentrations ranging from 24 to 150 $\mu\text{g/kg}$ and 7.3 to 13 $\mu\text{g/kg}$, respectively. Bis(2-ethylhexyl)phthalate was detected in SB2 (5.0-7.0') at a concentration of 79.4 $\mu\text{g/kg}$ and in SB3 (6.0-8.0') at a concentration of 67.5 $\mu\text{g/kg}$. Di-n-butylphthalate was detected at concentrations of 85.8 to 90.4 $\mu\text{g/kg}$ in SB3.

Arsenic was detected above the upper background level (11 mg/kg) in SB2 (5.0-7.0'), where it was found at a concentration of 12.8 $\mu\text{g/kg}$. Barium concentrations ranged from 300 to 324 mg/kg in SB2 (5.0-7.0') and SB3 (6.0-8.0'). SB3 (6.0-8.0') contained an elevated concentration of zinc (120 mg/kg), well above the upper background level of 53 mg/kg. Concentrations of several metals were very high in SB3 (16.0-18.0'), including cadmium, nickel, and zinc.

4.3.17 Primary Clarifiers (SWMU 32.3)

At this SWMU, four soil gas samples and one surface soil sample were collected. Four soil borings were drilled and seven samples were collected.

Soil Gas. Only compounds 1,1-DCE and 1,2-DCA were detected at SWMU 32.3 (Table 4.36). The compound 1,1-DCE was detected in SG1 (1 ppmv), SG2 (0.5 ppmv), and SG3 (4 ppmv). SG3 also contained 1,2-DCA at 7 ppmv.

Surface Soil. One surface soil sample was taken at this site (Table 4.37). Chloroform (1.8 $\mu\text{g/kg}$), methylene chloride (10 $\mu\text{g/kg}$), and PCE (7.8 $\mu\text{g/kg}$) were the only VOCs found in the sample. SVOCs detected included bis(2-ethylhexyl)phthalate (235 $\mu\text{g/kg}$), fluoroanthene (87.8 $\mu\text{g/kg}$), and pyrene (73.5 $\mu\text{g/kg}$).

Cyanide and selenium were not found in the surface soil sample. Cadmium was detected at 2.13 mg/kg, slightly above the background level of <2 mg/kg. All other metals were within their respective background concentration ranges.

Soil Borings. A total of three soil borings (SB1, SB2, and SB4) were sampled at this location (Table 4.37). Acetone and methylene chloride were detected in SB2 and SB4. Acetone was detected at concentrations ranging from 27 to 1100 $\mu\text{g/kg}$ and methylene chloride was detected at concentrations ranging from 8.8 to 32 $\mu\text{g/kg}$. The compounds MEK and toluene were detected in SB2 (4.0-6.0') at low concentrations of 1.5 $\mu\text{g/kg}$ and 1.1 $\mu\text{g/kg}$, respectively. Bis(2-ethylhexyl)phthalate was detected in all soil borings sampled (SB1, SB2, and SB4) at concentrations ranging from 46 to 224 $\mu\text{g/kg}$. Di-n-butylphthalate was detected in SB4 at concentrations ranging from 39 to 53.8 $\mu\text{g/kg}$. In addition, SB2 (4.0-6.0') contained five PAHs (benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, chrysene, and indeno[1,2,3-c,d]pyrene) at concentrations ranging from 42 to 153 $\mu\text{g/kg}$.

Selenium was detected in SB1 (4.0-6.0') and SB4 (6.0-6.5') at concentrations ranging from 0.70 to 0.89 mg/kg. Zinc was detected in SB2 (4.0-6.0') at concentrations of 105 mg/kg, above the upper background concentration of 53 mg/kg.

Table 4.35 Chemical Constituents Detected in Soils, October 1993
SWMU 32.2, Flocculation Chamber
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth				
	S32.2SB2 5.0-7.0 ft.	S32.2SB2D ¹ 5.0-7.0 ft.	S32.2SB2 12.5-15.0 ft.	S32.2SB3 6.0-8.0 ft.	S32.2SB3 16.0-18.0 ft.
Background Range ²					
Volatile organic compounds (µg/kg):					
Acetone	59 (J4)	24 (J4)	32 (J4)	36 (J4)	150 (J4)
Methylene chloride	12 (J1)	8.7 (J1)	7.3 (J1)	13 (J1)	7.5 (J1)
Semivolatile organic compounds (µg/kg):					
di-n-Butylphthalate	ND	38 (J1)†	ND	85.8 (J1)	90.4 (J1)
bis(2-Ethylhexyl)phthalate	79.4 (J1)†	52.5 (J1)†	ND	67.5 (J1)†	57.4 (J1)†
Cyanide (mg/kg)	ND	ND	ND	ND	ND
Metals (mg/kg):					
Arsenic	12.8	13.1	ND	2.83	1.17
Barium	300	272	27.4	324	53.6
Cadmium	ND	ND	ND	ND	102
Chromium, total	23.8 (J4)	20.5 (J4)	4.37 (J4)	8.37 (J4)	50.6 (J4)
Lead	5.4	5.27	ND	5.3	3.73
Nickel	29.1	28.8	3.71	5.77	98.8
Selenium	ND	0.56	ND	ND	ND
Zinc	40.2	37.6	3.6	120	109

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ S32.2SB2D (5.0-7.0 ft.) is a replicate of S32.2SB2 (5.0-7.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

Note: S32.2SB1 was not drilled.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.36
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 32.3, Primary Clarifiers
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/ 1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
SWT 32.3 SG1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J
SWT 32.3 SG2	<1	0.5 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.3 SG3	<1	44	<1	<1	<1	7	<1	<1	<1	<1	<1	0.9 J
SWT 32.3 SG4	<1	<1	<1	<1	<1	0.3 J	<1	<1	<1	<1	<1	1

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

450RBAU101SG3R3T2WK3

Table 4.37 Chemical Constituents Detected in Soils, October and November 1993
SWMU 32.3, Primary Clarifiers
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth								Background Range ²
	S32.3SS1* 0.17-0.33 ft.	S32.3SB1 4.0-6.0 ft.	S32.3SB1D1 4.0-6.0 ft.	S32.3SB1 9.5-10.0 ft.	S32.3SB2 4.0-6.0 ft.	S32.3SB2 12.0-12.7 ft.	S32.3SB4 6.0-6.5 ft.	S32.3SB4 17.0-17.5 ft.	
Volatile organic compounds (µg/kg):									
Acetone	ND	35 (J1)	68	ND	190 (J6)	1100 (J6)	42	27	NA
2-Butanone (MEK)	ND	ND	ND	ND	1.5 (J5)	ND	ND	ND	NA
Chloroform	1.8 (J1)	ND	ND	ND	ND	ND	ND	ND	NA
Methylene chloride	10 (J4)	13 (J1)	4 (J5)	ND	13 (J1)	32 (J1)	10 (J1)	8.8 (J1)	NA
Tetrachloroethene (PCE)	7.8	ND	ND	ND	ND	ND	ND	ND	NA
Toluene	ND	1.2 (J5)	ND	ND	1.1 (J5)	ND	ND	ND	NA
Semivolatile organic compounds (µg/kg):									
Benzo(a)pyrene	ND	ND	ND	ND	74 (J5)	ND	ND	ND	NA
Benzo(b)fluoranthene	ND	ND	ND	ND	153 (J5)	ND	ND	ND	NA
Benzo(g,h,i)perylene	ND	ND	ND	ND	105 (J5)	ND	ND	ND	NA
di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	53.8 (J1)	39 (J1)†	NA
Chrysene	ND	ND	ND	ND	71 (J5)	ND	ND	ND	NA
bis (2-Ethylhexyl)phthalate	235 (J1)	59 (J1)†	ND	46 (J1)†	224 (J1)	210 (J1)	59.3 (J1)†	60 (J1)†	NA
Fluoranthene	87.8 (J5)	ND	ND	ND	ND	ND	ND	ND	NA
Indeno(1,2,3-c,d)pyrene	ND	ND	ND	ND	42 (J5)†	ND	ND	ND	NA
Pyrene	73.5 (J5)†	ND	ND	ND	ND	ND	ND	ND	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA
PCBs (µg/kg)									
Arochlor 1254	17	NA	NA	NA	NA	NA	NA	NA	NA
Metals (mg/kg):									
Arsenic	4.15 (J4)	10.6	5.92	2.98	4.04	2.65	1.62	1.18	2-11
Barium	286	95.3 (J4)	58.6 (J4)	87.2 (J4)	77.4	61.1	84.7	66.7	47-570
Cadmium	2.13	ND	ND	ND	0.76	0.77	ND	ND	<2.0
Chromium, total	52.2	41.5 (J4)	24.9 (J4)	29.9 (J4)	24.7	14.8	11.5 (J4)	6.46 (J4)	6-74

Table 4.37, cont.

Chemical	Sample Identification and Depth								Background Range ²
	S32.3SS1* 0.17-0.33 ft.	S32.3SB1 4.0-6.0 ft.	S32.3SB1D ¹ 4.0-6.0 ft.	S32.3SB1 9.5-10.0 ft.	S32.3SB2 4.0-6.0 ft.	S32.3SB2 12.0-12.7 ft.	S32.3SB4 6.0-6.5 ft.	S32.3SB4 17.0-17.5 ft.	
Metals, cont.									
Lead	12.4	11.9	9.49	6.96	8.84	4.75	4.64	1.94	<4-48
Nickel	35	32.6	26.2	17.8	15.9	8.17	12.1	7.97	6-32
Selenium	ND	0.89	0.78	ND	ND	ND	0.7	ND	<0.1-0.2
Silver	1.06 (J ₄)	ND	ND	ND	ND	ND	ND	ND	<2.0
Zinc	31.9	48.6	32.2	24	105	12.6	14.4	8.08	5-53

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ S32.3SB1D (4.0-6.0 ft.) is a replicate of S32.3SB1 (4.0-6.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

4.3.18 Trickling Filters (SWMU 32.4)

Twelve soil gas samples were collected and six soil borings were drilled at this SWMU. A total of twelve soil boring samples were collected.

Soil Gas. Nine out of eleven target compounds were detected in the soil gas samples (Table 4.38). Vinyl chloride and benzene were the only compounds not detected in at least one sample. Trace levels of 1,1-DCE were detected in all samples from this SWMU. Only one compound, PCE, was detected above the quantitation limit of 1 ppmv. Trace levels of PCE were detected in all samples except SG4, SG5, and SG6.

Soil Borings. A total of six soil borings (SB1 through SB6) were sampled at this location (Table 4.39). Acetone and methylene chloride were detected in all soil borings except SB6. Concentrations of acetone reached a maximum of 240 $\mu\text{g/kg}$ in SB3 (6.0-8.0'). Concentrations of methylene chloride reached a maximum of 31 $\mu\text{g/kg}$ in SB1 (7.0-7.5') and SB3 (14.0-16.0'). Bis(2-ethylhexyl)phthalate was detected in all soil borings except SB1. Concentrations of this compound reached a maximum of 270 $\mu\text{g/kg}$ in SB4 (10.0-12.0').

The maximum concentration of arsenic was 20.2 mg/kg in SB2 (7.5-9.0'). The maximum concentration of barium was 374 mg/kg in SB2 (0.0-2.0'). Selenium was found only in SB4 (15.0-16.0'), where the concentration was 0.58 mg/kg. All other metal concentrations were within or below the background ranges.

4.3.19 Final Clarifiers (SWMU 32.5)

At this SWMU, two soil gas samples were collected, and three soil borings were drilled. Three soil gas samples were attempted; however, subsurface conditions prevented the collection of sample SG1. A total of seven soil boring samples were collected.

Soil Gas. Vinyl chloride and 1,1-DCE were the only VOCs detected in the soil gas samples (Table 4.40). The concentration of vinyl chloride detected in SG3 was 0.2 ppmv. The compound 1,1-DCE was detected in SG2 and SG3 at 2 ppmv and 0.5 ppmv, respectively.

Soil Borings. Three soil borings (SB1, SB2, and SB3) were sampled at this location (Table 4.41). Acetone and methylene chloride were detected in SB2 and SB3 at concentrations ranging from 55 to 130 $\mu\text{g/kg}$ and 5 to 28 $\mu\text{g/kg}$, respectively. PCE and toluene were detected in SB3 at concentrations ranging from 1.3 to 6.1 $\mu\text{g/kg}$ and 2.1 to 4.4 $\mu\text{g/kg}$, respectively. The compound MEK was also found in SB3 (6.0-7.5') at a concentration of 2 $\mu\text{g/kg}$. The SVOCs phenol, 2-chlorophenol, 4-chloro-3-methylphenol, 4-nitrophenol, and pentachlorophenol were detected in all three soil borings at concentrations ranging from 102 to 340 $\mu\text{g/kg}$. Bis(2-ethylhexyl)phthalate was also detected in all three soil borings at concentrations ranging from 41 to 99 $\mu\text{g/kg}$.

Arsenic was detected in all soil borings, reaching a maximum concentration of 4.98 mg/kg in SB3 (2.0-4.0'). The highest concentration of barium was 357 mg/kg in SB1 from 5.0 to 6.0 feet bgs. Mercury was detected at a concentration of

Table 4.38
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 32.4, Trickling Filters
Tinker AFB, Oklahoma

Sample	1,1,1-TCA/ Vinyl Chloride											Unknowns (ppmv)
	(ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	
SWT 32.4 SG1	<1	0.3 J	<1	0.7 J	<1	<1	0.4 J	0.1 J	0.6 J	0.6 J	<1	0.8 J
SWT 32.4 SG2	<1	0.6 J	0.1 J	0.6 J	<1	<1	0.6 J	0.1 J	1	<1	<1	0.5 J
SWT 32.4 SG3	<1	0.2 J	<1	0.5 J	<1	<1	0.2 J	0.1 J	0.4 J	<1	0.2 J	0.6 J
SWT 32.4 SG4	<1	0.3 J	<1	0.1 J	<1	<1	<1	<1	<1	0.2 J	0.3 J	0.3 J
SWT 32.4 SG5	<1	0.7 J	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	0.7 J
SWT 32.4 SG6	<1	0.5 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.4 J
SWT 32.4 SG7	<1	0.6 J	<1	<1	<1	<1	<1	<1	0.1 J	<1	<1	0.3 J
SWT 32.4 SG8	<1	0.4 J	<1	0.3 J	<1	0.1 J	<1	<1	0.4 J	<1	<1	0.7 J
SWT 32.4 SG9	<1	0.9 J	<1	<1	<1	0.1 J	<1	<1	0.5 J	<1	<1	0.2 J
SWT 32.4 SG10	<1	0.8 J	<1	0.3 J	<1	<1	<1	<1	0.7 J	<1	<1	0.7 J
SWT 32.4 SG50*	<1	0.7 J	<1	<1	<1	<1	<1	<1	0.6 J	<1	<1	1.3
SWT 32.4 SG11	<1	0.6 J	<1	0.3 J	<1	0.2 J	<1	<1	0.5 J	<1	<1	0.9 J
SWT 32.4 SG12	<1	0.7 J	0.1 J	<1	<1	0.2 J	<1	<1	0.1 J	<1	<1	0.6 J

450RBAU/ARI/SGS85T2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

Table 4.39 Chemical Constituents Detected in Soils, October and November 1993
SWMU 32.4, Trickling Filters
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth					Background Range ¹
	S32.4SB1 7.0-7.5 ft.	S32.4SB2 0.0-2.0 ft.	S32.4SB2 7.5-9.0 ft.	S32.4SB3 6.0-8.0 ft.	S32.4SB3 14.0-16.0 ft.	S32.4SB4 10.0-12.0 ft.
Volatile organic compounds ($\mu\text{g/kg}$):						
Acetone	30 (J ₁)	58 (J ₆)	84 (J ₆)	240 (J ₆)	76 (J ₆)	69 (J ₆)
Methylene chloride	31 (J ₁)	14 (J ₁)	13 (J ₁)	25 (J ₁)	31 (J ₁)	11 (J ₁)
Tetrachloroethene (PCE)	ND	3.7 (J ₅)	ND	ND	ND	ND
Toluene	ND	1.9 (J ₅)	ND	1.8 (J ₅)	2.3 (J ₅)	ND
Semivolatile organic compounds ($\mu\text{g/kg}$):						
bis(2-Ethylhexyl)phthalate	ND	37 (J ₁)†	160 (J ₁)	46 (J ₁)†	49 (J ₁)†	270 (J ₁)
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND
Metals (mg/kg):						
Arsenic	4.87	3.26	20.2	4.08	1.94	ND
Barium	371	374	52	92.6	22.2	34.2
Cadmium	ND	0.84	0.89	0.43	0.46	0.43
Chromium, total	15.5 (J ₄)	19.2	27.7	11.5	6.5	5.6
Lead	4.52	5.37	6.03	3.44	1.6	2.15
Nickel	14.6	13.5	21.7	6.56	4.33	5.27
Selenium	ND	ND	ND	ND	ND	ND
Zinc	18.3	17.9	27	9.57	5.93	5.06

Table 4.39 continued

Chemical	Sample Identification and Depth						Background Range ¹
	S32.4SB4 15.0-16.0 ft.	S32.4SB5 5.0-7.0 ft.	S32.4SB5 13.0-15.0 ft.	S32.4SB5 15.0-16.0 ft.	S32.4SB6 4.0-5.5 ft.	S32.4SB6 8.0-8.5 ft.	
Volatile organic compounds ($\mu\text{g}/\text{kg}$):							
Acetone	34 (J ₆)	32 (J ₆)	75 (J ₆)	60 (J ₆)	ND	ND	NA
Methylene chloride	22 (J ₁)	ND	10 (J ₁)	ND	ND	ND	NA
Tetrachloroethene (PCE)	1.6 (J ₅)	ND	ND	ND	ND	ND	NA
Toluene	1.8 (J ₅)	ND	ND	ND	ND	ND	NA
Semivolatile organic compounds ($\mu\text{g}/\text{kg}$):							
bis(2-Ethylhexyl)phthalate	69 (J ₁)†	59 (J ₁)†	ND	57 (J ₁)†	ND	79 (J ₁)†	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	NA
Metals (mg/kg):							
Arsenic	1.96	2.41	ND	ND	2.74	3.22	2-11
Barium	41.7	296	64	32.3	236 (J ₄)	313 (J ₄)	47-570
Cadmium	0.58	0.46	0.45	ND	ND	ND	<2.0
Chromium, total	13.8	7.45	3.49	2.28	18.6 (J ₄)	25.6 (J ₄)	6-74
Lead	1.5	2.86	0.79	0.46	3.77	11.8	<4-48
Nickel	5.76	10.8	4.84	3.88	10.3	15.4	6-32
Selenium	0.58	ND	ND	ND	ND	ND	<0.1-0.2
Zinc	6.91	12.3	5.41	3.54	13.9	22.3	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.40
 Chemical Constituents Detected in Soil Gas, September and October 1993
 SWMU 32.5, Final Clarifiers
 Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE		1,1-DCA		1,1,1-TCA/1,2-DCE		Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		(ppmv)	(ppmv)	(ppmv)	(ppmv)	(ppmv)	(ppmv)								
SWT 32.5 SG2	<1	2		<1		<1		<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.5 SG3	0.2 J	0.5 J		<1		<1		<1	<1	<1	<1	<1	<1	<1	<1

450REBAU0015GSRST2.WK3

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

DCA = dichloroethane TCE = trichloroethene
 DCE = dichloroethene PCE = tetrachloroethene
 TCA = trichloroethane ppmv = parts per million vapor

Note: IWT 32.5 SG1 was not collected.

Table 4.41 Chemical Constituents Detected in Soils, November 1993
SWMU 32.5, Final Clarifiers
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth							Background Range ²
	S32.5SB1 2.0-3.0 ft.	S32.5SB1 5.0-6.0 ft.	S32.5SB2 3.5-4.0 ft.	S32.5SB2 5.5-6.0 ft.	S32.5SB3 2.0-4.0 ft.	S32.5SB3D ¹ 2.0-4.0 ft.	S32.5SB3 6.0-7.5 ft.	
Volatile organic compounds (µg/kg):								
Acetone	ND	ND	55 (J ₁)	ND	130 (J ₄)	56 (J ₄)	120 (J ₄)	NA
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	2 (J ₅)	NA
Methylene chloride	ND	ND	28 (J ₁)	ND	6.2 (J ₄)	6.3 (J ₄)	5 (J ₄)	NA
Tetrachloroethene (PCE)	ND	ND	ND	ND	6.1	1.3 (J ₄)	1.4 (J ₄)	NA
Toluene	ND	ND	ND	ND	4.4 (J ₆)	3.4 (J ₆)	2.1 (J ₆)	NA
Semivolatile organic compounds (µg/kg):								
di-n-Butylphthalate	ND	ND	ND	41 (J ₅)†	ND	ND	ND	NA
2-Chlorophenol	260 (J ₁)	260 (J ₁)	280 (J ₁)	280 (J ₁)	293 (J ₁)	309 (J ₁)	339 (J ₁)	NA
4-Chloro-3-methylphenol	280 (J ₁)	290 (J ₁)	270 (J ₁)	290 (J ₁)	273 (J ₁)	232 (J ₁)	191 (J ₁)	NA
bis(2-Ethylhexyl)phthalate	66 (J ₅)†	85 (J ₅)†	90 (J ₅)†	99 (J ₅)	46 (J ₁)†	41 (J ₁)†	ND	NA
4-Nitrophenol	210 (J ₁)	240 (J ₁)	190 (J ₁)	200 (J ₁)	239 (J ₆)	226 (J ₆)	188 (J ₆)	NA
Pentachlorophenol	210 (J ₁)†	250 (J ₁)†	150 (J ₁)†	140 (J ₁)†	171 (J ₁)†	151 (J ₁)†	102 (J ₁)†	NA
Phenol	260 (J ₁)	260 (J ₁)	270 (J ₁)	280 (J ₁)	326 (J ₁)	340 (J ₁)	168 (J ₁)	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	NA
Metals (mg/kg):								
Arsenic	2.44	3.51	4.52	3.16	4.03	4.98	1.61	2-11
Barium	134	357	222	70	240 (J ₆)	285 (J ₆)	38.2 (J ₆)	47-570
Cadmium	0.99	1.69	1.79	1.09	ND	ND	ND	<2.0
Chromium, total	12.3	21.6	10.6	14	15.6 (J ₄)	17.4 (J ₄)	6.44 (J ₄)	6-74
Lead	3.78	8.58	7.68	4.8	5.98	5.56	2.35	<4-48

Table 4.41, cont.

Chemical	Sample Identification and Depth							
	S32.5SB1 2.0-3.0 ft.	S32.5SB1 5.0-6.0 ft.	S32.5SB2 3.5-4.0 ft.	S32.5SB2 5.5-6.0 ft.	S32.5SB3 2.0-4.0 ft.	S32.5SB3D1 2.0-4.0 ft.	S32.5SB3 6.0-7.5 ft.	Background Range ²
Mercury	ND	ND	ND	ND	ND	0.12 (J4)	ND	NA
Nickel	7.89	16.8	7.88	8.19	14.7 (J4)	14.2 (J4)	4.96 (J4)	6-32
Selenium	0.56	ND	ND	ND	ND	ND	ND	<0.1-0.2
Silver	0.56	1.33	ND	0.11	ND	ND	ND	<2.0
Zinc	12.8	23.3	9.67	9.06	17.4 (J4)	17.1 (J4)	6.44 (J4)	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ S32.5SB3D (2.0-4.0 ft.) is a replicate of S32.5SB3 (2.0-4.0 ft.).

² Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

0.12 mg/kg in SB3D, a duplicate of SB3 (2.0-4.0'). Selenium was detected above the background range (<0.1-0.2 mg/kg) in SB1 (2.0-3.0'), where it was found at a concentration of 0.556 mg/kg. Silver was also detected above the background level (<2 mg/kg) in SB1 (5.0-6.0'), where it was found at a concentration of 133 mg/kg.

4.3.20 Former Chlorine Contact Chamber (SWMU 32.6)

Two soil gas samples were collected and one soil boring was drilled at this SWMU. Only one sample was collected from the soil boring.

Soil Gas. Only one compound, 1,1-DCE, was detected in the SWMU 32.6 soil gas samples (Table 4.42). The concentrations ranged from 0.1 ppmv (SG2) to 1 ppmv (SG1).

Soil Borings. Only one soil boring (SB1) was sampled at this location (Table 4.43). No VOCs were found, but several SVOCs were detected in SB1 (2.0-3.0'). The SVOCs included bis(2-ethylhexyl)phthalate, phenol, and six phenol compounds. All of the SVOC analytes were qualified during data validation as also being detected in the laboratory blanks.

Analyses for metals, including arsenic, barium, lead, nickel, silver, and zinc, showed concentrations within respective background levels. Cadmium and total chromium concentrations were relatively high. Cadmium was detected at a concentration of 4.83 mg/kg, total chromium at 118 mg/kg.

4.3.21 Drying Beds (SWMU 32.8)

At this SWMU, twenty-four soil gas samples and four surface soil samples were collected. Eighteen soil borings were drilled and forty-four samples were collected. Sample number SG13 was skipped. Unsuccessful attempts were made to collect samples at SG14 and SG15. The sampling probe could not be driven to depths greater than 18 inches because of subsurface conditions.

Soil Gas. All eleven target compounds in the soil gas samples were detected (Table 4.44). The highest concentrations of 1,1-DCE (340 ppmv), 1,2-DCA (38 ppmv), and toluene (2 ppmv), were detected in SG9. Sample SG25 had the highest concentrations of 1,1,1-TCA/1,2-DCE (69 ppmv) and PCE (1,100 ppmv). Vinyl chloride was found in SG26 and SG27 at 4 and 2 ppmv, respectively. The compound 1,1-DCA was found in SG7 at 6.6 ppmv, but below detection limits in the duplicate SG70. Benzene was detected in one sample, SG22, at 33 ppmv. The remaining compounds were detected at concentrations less than 1 ppmv.

Surface Soil. Four surface soil samples and one duplicate were collected at this site (Table 4.45). PCE was detected at all four locations at concentrations ranging from 1.8 to 2.6 µg/kg. Methylene chloride was detected in SS2 and SS3 at 1.7 µg/kg, and toluene was detected in SS3 at 1.1 µg/kg. Acetone was found in SS1 (86 µg/kg) and SS3 (16 µg/kg).

Sample SS2 had the highest total concentration of SVOCs (809.4 µg/kg), as well as the largest number of SVOCs found (five). Bis(2-ethylhexyl)phthalate was detected in all samples in concentrations ranging from 88.7 to 578 µg/kg. Fluoranthene was detected in SS2 (119 µg/kg) and in its duplicate (90.1 µg/kg).

Table 4.42
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 32.6, Former Chlorine Contact Chamber
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1,1-TCA/ 1,1-DCE				Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
		1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,2-DCE (ppmv)	1,2-DCA (ppmv)								
SWT 32.6 SG1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.6 SG2	<1	0.1 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.6 SG51*	<1	0.5 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene
DCE = dichloroethene PCE = tetrachloroethene
TCA = trichloroethane ppmv = parts per million vapor

450RBAU/01/1505RST2.WK3

Table 4.43 Chemical Constituents Detected in Soils, November 1993
SWMU 32.6, Former Chlorine Contact Chamber
Tinker AFB, Oklahoma

Chemical	S32.6SB1 2.0-3.0 ft.	Background Range ¹
Volatile organic compounds (µg/kg)	ND	NA
Semivolatile organic compounds (µg/kg):		
4-Chloro-3-methylphenol	360 (J ₁)	NA
2-Chlorophenol	310 (J ₁)	NA
bis(2-Ethylhexyl)phthalate	114 (J ₅)	NA
2-Methylphenol	79 (J ₅)	NA
4-Methylphenol	41 (J ₅)†	NA
4-Nitrophenol	210 (J ₁)	NA
Pentachlorophenol	200 (J ₁)†	NA
Phenol	410 (J ₁)	NA
Cyanide (mg/kg)	ND	NA
Metals (mg/kg):		
Arsenic	2.47	2-11
Barium	258	47-570
Cadmium	4.83	<2.0
Chromium, total	118	6-74
Lead	32.2	<4-48
Nickel	24.6	6-32
Silver	2.14	<2.0
Zinc	33.1	5-53

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ Background concentrations are from USGS report, 1991.

† The compound was positively identified at a concentration below the method detection limit.

Data qualifiers follow the data in parentheses and are defined as follows:

J The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

Table 4.44
Chemical Constituents Detected in Soil Gas, September and October 1993
SWMU 32.8, Drying Beds
Tinker AFB, Oklahoma

Sample	Vinyl Chloride (ppmv)	1,1-DCE (ppmv)	1,1-DCA (ppmv)	1,1,1-TCA/1,2-DCE (ppmv)	Benzene (ppmv)	1,2-DCA (ppmv)	TCE (ppmv)	Toluene (ppmv)	PCE (ppmv)	Ethylbenzene (ppmv)	o-Xylene (ppmv)	Unknowns (ppmv)
SWT 32.8 SG1	<1	0.8 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J
SWT 32.8 SG2	<1	<1	0.1 J	0.3 J	<1	0.2 J	<1	<1	<1	<1	<1	2
SWT 32.8 SG3	<1	1	<1	<1	<1	0.4 J	<1	<1	<1	<1	<1	0.2 J
SWT 32.8 SG57*	<1	0.9 J	<1	2	<1	0.2 J	<1	<1	0.3 J	<1	<1	0.9 J
SWT 32.8 SG4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.5 J
SWT 32.8 SG5	<1	170	<1	10	<1	14	<1	<1	2	<1	<1	0.3 J
SWT 32.8 SG6	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.3 J
SWT 32.8 SG7	<1	300	66	43	<1	35	<1	<1	<1	<1	<1	2
SWT 32.8 SG8	<1	0.4 J	<1	0.7 J	<1	<1	<1	<1	<1	<1	<1	0.1 J
SWT 32.8 SG9	<1	340	<1	43	<1	38	0.8 J	2	<1	<1	<1	8
SWT 32.8 SG10	<1	1	<1	2	<1	0.2 J	<1	<1	<1	<1	<1	<1
SWT 32.8 SG11	<1	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J
SWT 32.8 SG12	<1	0.2 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.1 J
SWT 32.8 SG16	<1	<1	<1	1	<1	0.1 J	<1	<1	<1	<1	<1	0.6 J
SWT 32.8 SG17	<1	0.5 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.8 SG55*	<1	0.4 J	<1	0.3 J	<1	0.3 J	<1	<1	<1	<1	<1	0.2 J
SWT 32.8 SG18	<1	<1	<1	0.3 J	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.8 SG19	<1	0.5 J	<1	0.4 J	<1	<1	<1	<1	<1	<1	<1	0.3 J
SWT 32.8 SG20	<1	2	<1	0.6 J	<1	0.1 J	<1	<1	<1	<1	<1	0.9 J
SWT 32.8 SG21	<1	0.7 J	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SWT 32.8 SG22	<1	0.7 J	<1	<1	33	<1	<1	<1	0.3 J	<1	<1	64
SWT 32.8 SG23	<1	0.6 J	<1	0.2 J	<1	<1	<1	<1	40	<1	<1	<1
SWT 32.8 SG24	<1	33	<1	69	<1	1	<1	<1	1100	<1	<1	750
SWT 32.8 SG25	<1	<1	<1	0.4 J	<1	1	<1	0.2 J	3	<1	<1	8
SWT 32.8 SG70*	<1	0.1 J	<1	0.5 J	<1	2	<1	0.1 J	0.5 J	0.1 J	0.1 J	16
SWT 32.8 SG26	4	0.4 J	<1	0.6 J	<1	0.1 J	<1	0.2 J	0.5 J	0.1 J	<1	7
SWT 32.8 SG27	2	0.3 J	<1	0.3 J	<1	<1	<1	0.1 J	0.2 J	<1	<1	0.5 J

J The associated numerical value is an estimated quantity because the reported concentrations were less than the quantitation limits.

* Duplicates listed immediately after sample collection location.

DCA = dichloroethane TCE = trichloroethene

DCE = dichloroethene PCE = tetrachloroethene

TCA = trichloroethane ppmv = parts per million vapor

450RBAU(0)SGSRT2.WK3

Table 4.45. Chemical Constituents Detected in Soils, October and November 1993
SWMU 32.8 Drying Beds
Tinker AFB, Oklahoma

Chemical	Sample Identification and Depth										Background Range ²
	S32.8SS1* 0.17-0.33 ft.	S32.8SS2* 0.17-0.33 ft.	S32.8SS2D1* 0.17-0.33 ft.	S32.8SS3* 0.17-0.33 ft.	S32.8SS4* 0.17-0.33 ft.	S32.8SB1 5.5-7.5 ft.	S32.8SB1 14.5-16.5 ft.	S32.8SB2 0.0-2.0 ft.	S32.8SB2 9.0-12.0 ft.		
Volatile organic compounds (µg/kg):											
Acetone	86	ND	ND	16 (J4)	ND	23	32	110 (J1)	100 (J1)	NA	
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Methylene chloride	ND	1.7 (J4)†	2.8 (J4)	1.7 (J4)†	ND	9.3 (J1)	11 (J1)	55 (J1)	56 (J1)	NA	
Tetrachloroethene (PCE)	2.6 (J5)	1.8 (J5)	1.8 (J5)	2.6 (J5)	2.2 (J5)	ND	1.5 (J5)	ND	ND	NA	
Toluene	ND	ND	ND	1.1 (J1)	ND	ND	1.5 (J5)	4.2 (J5)	4.5 (J5)	NA	
Semivolatile organic compounds (µg/kg):											
Benzo(h)fluoranthene	ND	89.4 (J5)†	ND	ND	ND	ND	ND	ND	ND	NA	
Butylbenzylphthalate	ND	217 (J5)	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	72.7 (J1)†	310 (J1)	578 (J1)	88.7 (J1)†	206 (J1)	49.7 (J1)†	48.1 (J1)†	ND	ND	NA	
Fluoranthene	ND	119 (J5)	90.1 (J5)	ND	ND	ND	ND	ND	ND	NA	
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Pyrene	ND	74 (J5)†	ND	ND	ND	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	0.94 (J6)	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)											
	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Metals (mg/kg):											
Arsenic	ND	1.14 (J4)	1.66 (J4)	ND	3.04 (J4)	ND	ND	2.2	2.65	2-11	
Barium	428	400	271	343	228	34.8	36.1	199	66	47-570	
Cadmium	9.06	1.66	1.98	19.4	2.47	ND	ND	ND	ND	<2.0	
Chromium, total	322	59.4	67.4	3050	85.4	5.33 (J4)	5.25 (J4)	23.1 (J4)	7.61 (J4)	6-74	
Lead	19.8	48.1	40.3	32.1	11.2	1.21	0.53	4.4	1.73	<4.48	
Mercury	0.13	0.41	0.31	0.12	0.21	ND	ND	ND	ND	NA	
Nickel	63.3	46.3	57.3	54.4	36.1	4.48	3.78	11.1	5.19	6-32	
Selenium	ND	ND	ND	0.64	ND	ND	ND	0.55	ND	<0.1-0.2	
Silver	8.74 (J4)	1.56 (J4)	5.3 (J4)	1.06 (J4)	1.57 (J4)	ND	ND	ND	ND	<2.0	
Zinc	40.5	41.6	38.4	37	31.4	5.69	4.1	14.4	6.34	5-53	

Table 4.45 continued

Chemical	Sample Identification and Depth								Background Range ²
	S32.8SB2 12.0-15.0 ft.	S32.8SB3 6.0-8.0 ft.	S32.8SB3 12.5-14.0 ft.	S32.8SB4 8.0-9.0 ft.	S32.8SB4 12.0-13.5 ft.	S32.8SB5 6.0-7.0 ft.	S32.8SB5 11.5-13.5 ft.	S32.8SB6 11.5-13.0 ft.	
Volatile organic compounds (μg/kg):									
Acetone	88 (J ₁)	58 (J ₁)	300 (J ₆)	69 (J ₁)	50 (J ₁)	60 (J ₁)	62 (J ₁)	33 (J ₁)	NA
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	NA
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	NA
Methylene chloride	56 (J ₁)	50 (J ₁)	54 (J ₁)	9.3 (J ₁)	11 (J ₁)	10 (J ₁)	11 (J ₁)	15	NA
Tetrachloroethene (PCE)	ND	ND	1.8 (J ₁)	ND	ND	ND	ND	ND	NA
Toluene	4.6 (J ₅)	4.2 (J ₅)	4.6 (J ₅)	ND	ND	ND	ND	1.4 (J ₅)	NA
Semivolatile organic compounds (μg/kg):									
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA
bis(2-Ethylhexyl)phthalate	ND	110 (J ₁)	ND	ND	ND	160 (J ₁)	120 (J ₁)	ND	NA
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	NA
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA
PCBs (μg/kg)									
Metals (mg/kg):									
Arsenic	1.19	1.23	1.56	ND	3.81	1.77	ND	6.11	2-11
Barium	17.4	152	30.1	2240	27.3	179	25.8	66.3 (J ₄)	47-570
Cadmium	ND	ND	ND	50.5	ND	ND	ND	ND	<2.0
Chromium, total	11 (J ₄)	8.83 (J ₄)	22.4 (J ₄)	3000	3.45	18.4	2.37	9.46 (J ₄)	6-74
Lead	0.95	3.24	1.32	7.39 (J ₄)	1.19 (J ₄)	3.78 (J ₄)	0.35 (J ₄)	6.69	<4-48
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA
Nickel	2.74	7.49	4.2	168	3.45	31.3	3.9	4.04	6-32
Selenium	ND	ND	0.6	0.81	ND	0.83	ND	.69	<0.1-0.2
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Zinc	3.45	50	6.12	52.3	3.93	23.2	3.19	6.23	5-53

Table 4.45 continued

Chemical	Sample Identification and Depth									Background Range ²
	S32.8SB6 17.0-18.0 ft.	S32.8SB7 8.0-9.0 ft.	S32.8SB7 13.0-14.0 ft.	S32.8SB7D ³ 13.0-14.0 ft.	S32.8SB8 2.5-3.5 ft.	S32.8SB8 14.0-15.0 ft.	S32.8SB9 14.5-15.5 ft.	S32.8SB9 16.5-18.0 ft.		
Volatile organic compounds (µg/kg):										
Acetone	30 (J ₁)	47 (J ₁)	ND	23 (J ₁)	67 (J ₁)	41 (J ₁)	41 (J ₁)	52 (J ₁)	NA	
2-Butanone (MEK)	ND	ND	ND	ND	22	ND	ND	ND	NA	
Chlorobenzene	ND	ND	ND	ND	12	ND	ND	ND	NA	
Methylene chloride	16	11	ND	15	11	12	4.1 (J ₁)	3 (J ₁)	NA	
Tetrachloroethene (PCE)	2.8 (J ₅)	ND	ND	ND	ND	ND	1.3 (J ₅)	ND	NA	
Toluene	1.5 (J ₅)	ND	ND	ND	ND	ND	ND	ND	NA	
Semivolatile organic compounds (µg/kg):										
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Benzylbutylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	ND	140 (J ₁)	120 (J ₁)	72 (J ₁)†	130 (J ₁)	150 (J ₁)	56 (J ₁)†	48 (J ₁)†	NA	
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)										
	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Metals (mg/kg):										
Arsenic	7.59	1.4	ND	ND	2.53	ND	7.28	3.51	2-11	
Barium	40.5 (J ₄)	396	48.6	39.1	780	43.8	108	132	47-570	
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	<2.0	
Chromium, total	10.2 (J ₄)	9.66 (J ₆)	3.5 (J ₆)	2.06 (J ₆)	17.2 (J ₆)	5.12 (J ₆)	14.7	12.5	6-74	
Lead	5.79	19.8	0.72	0.61	5.41	2.38	8.52 (J ₄)	2.22 (J ₄)	<4-48	
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Nickel	5.02	19.8 (J ₄)	5.79 (J ₄)	3.27 (J ₄)	13.1 (J ₄)	6.19 (J ₄)	4.81	9.48	6-32	
Selenium	ND	0.58	ND	0.61	0.58	ND	ND	ND	<0.1-0.2	
Silver	ND	0.35	ND	ND	0.46	ND	ND	0.12	<2.0	
Zinc	7.07	18.6	4.46	ND	17.3	4.88	6.29	10.6	5-53	

Table 4.45 continued

Chemical	Sample Identification and Depth									Background Range ²
	S32.8SB10 11.0-12.0 ft.	S32.8SB10 14.5-16.0 ft.	S32.8SB10D ⁴ 14.5-16.0 ft.	S32.8SB11 15.0-16.5 ft.	S32.8SB11 16.5-17.5 ft.	S32.8SB12 10.0-11.5 ft.	S32.8SB12 17.0-18.0 ft.	S32.8SB13 13.0-14.5 ft.		
Volatile organic compounds (µg/kg):										
Acetone	21 (J ₁)	26 (J ₁)	28 (J ₁)	21 (J ₁)	30 (J ₁)	44 (J ₁)	100 (J ₁)	100 (J ₁)	NA	NA
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Methylene chloride	3 (J ₁)	3.5 (J ₁)	4.6 (J ₁)	3.3 (J ₁)	3.6 (J ₁)	ND	28 (J ₁)	30 (J ₁)	NA	NA
Tetrachloroethene (PCE)	1.7 (J ₅)	ND	1.5 (J ₅)	ND	ND	ND	ND	ND	NA	NA
Toluene	4.2 (J ₁)	ND	ND	ND	ND	ND	ND	ND	NA	NA
Semivolatile organic compounds (µg/kg):										
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
bis(2-Ethylhexyl)phthalate	60 (J ₁)†	52 (J ₁)†	66 (J ₁)†	55 (J ₁)†	46 (J ₁)†	52 (J ₁)†	ND	43 (J ₁)†	NA	NA
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
PCBs (µg/kg)										
Metals (mg/kg):										
Arsenic	4.09	2.57	3.86	3.62	ND	2.22	ND	2.2	2-11	2-11
Barium	136	89.2	76.5	51.3	45.8	176	45.7	52.2	47-570	47-570
Cadmium	ND	ND	ND	ND	ND	1.56	ND	ND	<2.0	<2.0
Chromium, total	6.41	5.85	7.14	14.5	5.48	11.1 (J ₄)	5.67 (J ₄)	6.71 (J ₄)	6-74	6-74
Lead	1.99 (J ₄)	1.4 (J ₄)	2.58 (J ₄)	7.24 (J ₄)	1.52 (J ₄)	2.67	1.42	2.86	<4-48	<4-48
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
Nickel	5.2	3.39	4.1	5.21	7.46	14.6	6.02	4.29	6-32	6-32
Selenium	0.55	ND	ND	ND	ND	ND	ND	ND	<0.1-0.2	<0.1-0.2
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0	<2.0
Zinc	7.41	5.03	5.62	3.51	4.2	10.1	4.13	6.16	5-53	5-53

Table 4.45 continued

Chemical	Sample Identification and Depth									Background Range ²
	S32.8SB13 16.0-18.0 ft.	S32.8SB14 9.5-11.5 ft.	S32.8SB14D ⁵ 9.5-11.5 ft.	S32.8SB14 16.5-18.0 ft.	S32.8SB15 9.5-11.0 ft.	S32.8SB15 15.5-17.0 ft.	S32.8SB15 17.0-18.0 ft.	S32.8SB16 4.5-6.5 ft.		
Volatile organic compounds (µg/kg):										
Acetone	80 (J ₁)	43 (J ₁)	98 (J ₁)	160 (J ₁)	23 (J ₁)	61 (J ₁)	1100 (J ₁)	17 (J ₁)	NA	
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Methylene chloride	ND	ND	31 (J ₁)	36 (J ₁)	22 (J ₁)	4 (J ₁)	ND	10	NA	
Tetrachloroethene (PCE)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Toluene	ND	ND	ND	ND	ND	ND	ND	1.1 (J ₅)	NA	
Semivolatile organic compounds (µg/kg):										
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	ND	ND	62 (J ₁) [†]	ND	ND	41.7 (J ₁) [†]	ND	ND	NA	
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Phenol	ND	ND	ND	ND	ND	205	ND	ND	NA	
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)										
Metals (mg/kg):										
Arsenic	3.14	ND	ND	1.49	1.5	2.19	2.79	4.01	2-11	
Barium	34.8	142	127	28.1	77.3	17.6	42.1	267 (J ₄)	47-570	
Cadmium	ND	ND	ND	ND	0.49	ND	ND	ND	<2.0	
Chromium, total	12 (J ₄)	28.2 (J ₄)	26.9 (J ₄)	16.5 (J ₄)	107 (J ₄)	61.4 (J ₄)	99.8 (J ₄)	18 (J ₄)	6-74	
Lead	2.67	1.57	2.29	0.87	6.52	2.53	2.79	5.32	<4.48	
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Nickel	4.42	5.94	6.76	6.59	285	15.1	13.5	11.3	6-32	
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	<0.1-0.2	
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0	
Zinc	5.93	4.48	5.61	2.86	8.22	3.68	6.58	14.9	5-53	

Table 4.45 continued

Chemical	Sample Identification and Depth									Background Range ²
	S32.8SB16D ⁶ 4.5-6.5 ft.	S32.8SB16 12.5-14.5 ft.	S32.8SB16 15.5-17.0 ft.	S32.8SB16 9.0-11.0 ft.	S32.8SB17 14.0-16.0 ft.	S32.8SB17 16.0-18.0 ft.	S32.8SB18 9.5-11.5 ft.	S32.8SB18 16.0-18.0 ft.		
Volatile organic compounds (µg/kg):										
Acetone	12 (J ₁)	26 (J ₁)	34 (J ₁)	37 (J ₁)	24 (J ₁)	55 (J ₁)	18 (J ₁)	44 (J ₁)	NA	
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Methylene chloride	12	14	13	27 (J ₁)	30 (J ₁)	38 (J ₁)	11 (J ₁)	11 (J ₁)	NA	
Tetrachloroethene (PCE)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Toluene	ND	ND	1.2 (J ₅)	ND	ND	ND	ND	ND	NA	
Semivolatile organic compounds (µg/kg):										
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	NA	
bis(2-Ethylhexyl)phthalate	ND	ND	50 (J ₁)†	ND	47 (J ₁)†	88 (J ₁)†	ND	51 (J ₁)†	NA	
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Cyanide (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	NA	
PCBs (µg/kg)										
	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Metals (mg/kg):										
Arsenic	4.3	5.62	3.34	2.88	ND	1.66	2.25	ND	2-11	
Barium	152 (J ₄)	60.8 (J ₄)	59.2 (J ₄)	91.4	23.1	30.5	58.2	33.2	47-570	
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	<2.0	
Chromium, total	19 (J ₄)	24.6 (J ₄)	6.57 (J ₄)	6.3 (J ₄)	4.82 (J ₄)	5.09 (J ₄)	6.75	2.21	6-74	
Lead	5.91	4.95	3.69	1.6	0.56	1.54	2.68 (J ₄)	0.47 (J ₄)	<4-48	
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	NA	
Nickel	13.6	12.9	4.5	8.87	3.7	3.08	4.82	2.91	6-32	
Selenium	ND	ND	0.58	ND	ND	ND	ND	ND	<0.1-0.2	

Table 4.45 continued

Chemical	Sample Identification and Depth								Background Range ²
	S32.8SB16D ⁶ 4.5-6.5 ft.	S32.8SB16 12.5-14.5 ft.	S32.8SB16 15.5-17.0 ft.	S32.8SB17 9.0-11.0 ft.	S32.8SB17 14.0-16.0 ft.	S32.8SB17 16.0-18.0 ft.	S32.8SB18 9.5-11.5 ft.	S32.8SB18 16.0-18.0 ft.	
Metals, cont.									
Silver	ND	ND	ND	ND	ND	ND	ND	ND	<2.0
Zinc	18.3	10.9	4.27	9.51	3.37	4.02	5.46	3.14	5-53

* Surface soil sample

SWMU = Solid Waste Management Unit

ND = not detected

NA = not applicable

¹ S32.8SS2D (0.17-0.33 ft.) is a replicate of S32.8SS2 (0.17-0.33 ft.).

² Background concentrations are from USGS report, 1991.

³ S32.8SB7D (13.0-14.0 ft.) is a replicate of S32.8SB7 (13.0-14.0 ft.).

⁴ S32.8SB10D (14.5-16.0 ft.) is a replicate of S32.8SB10 (14.5-16.0 ft.).

⁵ S32.8SB14D (9.5-11.5 ft.) is a replicate of S32.8SB14 (9.5-11.5 ft.).

⁶ S32.8SB16D (4.5-6.5 ft.) is a replicate of S32.8SB16 (4.5-6.5 ft.).

† The compound was positively identified at a concentration below the method detection limit.

The J data qualifiers follow the data in parentheses and indicate that the analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the sample. The data should be seriously considered for decision-making. The specific J qualifiers are described below:

J₁ Blank contamination. Indicates possible high bias and/or false positives.

J₂ Calibration range exceeded. Indicates possible low bias.

J₃ Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used.

J₄ Other QC criteria outside control limits. Bias not readily determined.

J₅ Value falls between the method detection limit (MDL) and method quantitation limit (MQL).

J₆ Data is qualified with two or more of the above qualifiers.

The other compounds found in SS2 were benzo(b)fluoranthene, butylbenzylphthalate, and pyrene. Cyanide was detected in SS3 at 0.94 $\mu\text{g}/\text{kg}$. No PCBs were detected at this SWMU.

The highest concentrations of cadmium, chromium, and selenium were 19.4 mg/kg, 3,050 mg/kg, and 0.64 mg/kg, respectively, found in sample SS3. Barium was detected at concentrations ranging from 228 mg/kg (SS4) to 428 mg/kg (SS1). The highest lead levels were found in SS2 and its duplicate at 48.1 mg/kg and 40.3 mg/kg, respectively.

Soil Borings. A total of eighteen soil borings (SB1 through SB18) were sampled at this location (Table 4.45). Acetone and methylene chloride were detected in all soil borings except SB6, SB7, SB8, and SB16. The highest concentrations of acetone were found in SB3 (300 $\mu\text{g}/\text{kg}$ at 12.5-14.0') and SB15 (1,100 $\mu\text{g}/\text{kg}$ at 17.0-18.0'). The highest concentrations of methylene chloride were found ranging from 50 to 56 $\mu\text{g}/\text{kg}$ in SB2 and SB3. PCE was detected in SB1, SB3, SB9, and SB10 at low concentrations, ranging from 1.3 to 1.8 $\mu\text{g}/\text{kg}$. In each instance, PCE was found in soil samples collected from 11.0 to 16.5 feet bgs. Toluene was detected in SB1, SB2, SB3, and SB10 at concentrations ranging from 1.5 to 4.6 $\mu\text{g}/\text{kg}$. The SVOC bis(2-ethylhexyl)phthalate was detected in all soil borings except SB2, SB4, SB6, and SB16. Concentrations of bis(2-ethylhexyl) phthalate ranged from 41.7 to 160 $\mu\text{g}/\text{kg}$. Phenol was found in one sample, SB15 (9.5 to 11'), at 205 $\mu\text{g}/\text{kg}$.

The maximum concentration of arsenic was found in SB6 (17-18') at 7.59 mg/kg. Lead was detected in SB7 (8.0-9.0'), where it was found at 19.8 mg/kg. The highest concentration of barium, cadmium, total chromium, and zinc were 2,240 mg/kg, 50.5 mg/kg, 3,000 mg/kg and 52.3 mg/kg, respectively, detected in SB4 from 8.0 to 9.0 feet bgs. Total chromium was found in SB14 (9.5-11.5'), SB15 (9.5-18.0'), and SB16 (12.5-17.0') at concentrations ranging from 24.6 to 107 mg/kg. Nickel was detected well above the upper background level (32 mg/kg) in SB4 (8.0-9.0') and SB15 (9.5-11.0') at concentrations of 168 mg/kg and 285 mg/kg, respectively. Finally, selenium was detected above the background range (<0.1-0.2 mg/kg) in several soil borings (SB2, SB3, SB4, SB5, SB6, SB7, SB8, and SB10) at concentrations ranging from 0.55 to 0.83 mg/kg.

4.4 AIR SAMPLING

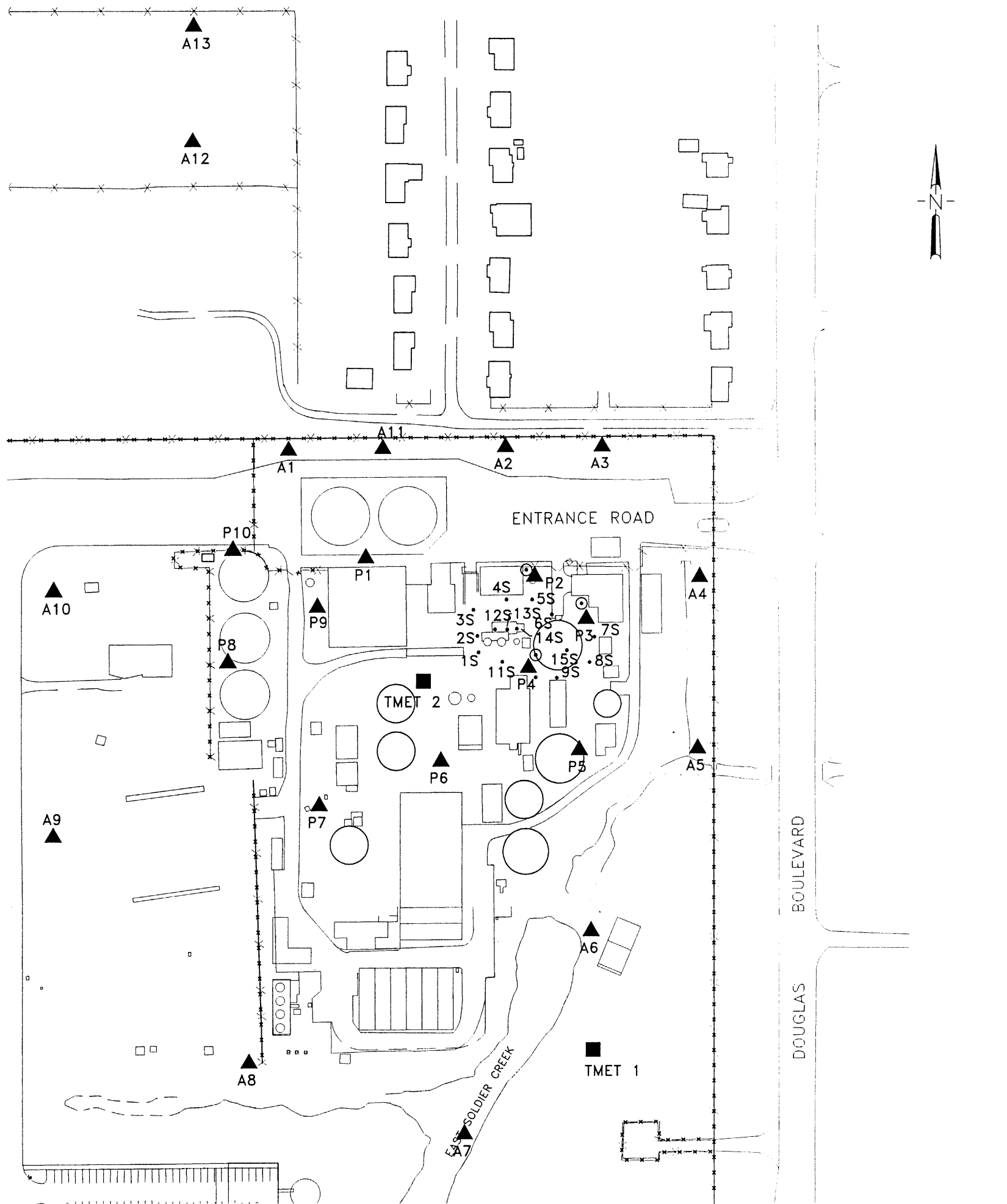
Ambient air, process exposure, and source emissions were sampled for several parameters over a period of 49 days from September through November 1993. Tinker AFB identified air emissions by fence line monitoring and included the process exposure and source sampling to verify that the IWTP influent was the source of contaminants and assess the volatilization from unit processes within the IWTP. The sampling was also undertaken to provide data for subsequent dispersion modeling and air pathway risk assessment, if needed. These additional data were collected with minimum cost via a single mobilization and sampling effort, combining the various objectives.

The types of samples are detailed in Table 4.46. The physical locations of sample collection sites are presented in Figure 4.5, and the sample collection and

Table 4.46
Types of Samples Collected
Air Analyses
September – November 1993
Tinker AFB, Oklahoma

Sample Type	Number of Samples Collected at			Total Samples
	Ambient	Process	Source	
VOC	271	206	138	615
SVOC	269	200	133	602
Phenol	271	210	128	609
Formaldehyde	63	50	60	173
TSP/Metals		9		9
H ₂ S	128			128
Mercaptan bags		14		14
GC bags			122	122
	<u>1002</u>	<u>689</u>	<u>581</u>	<u>2272</u>

450RB/au401/tot_samp.wk3



- LEGEND**
- ▲ AMBIENT AND
A4 PROCESS
 - TMET TOWERS
 - JEROME H₂S
ANALYSER
 - HI VOL
SAMPLERS
(P2,P3,P4)

100 0 100
SCALE FEET

FIGURE 4.5
AIR STATION
LOCATION MAP

TINKER AFB, OKLAHOMA

analysis procedures were described previously. The results for these parameters are reported in tables at the end of this section. These tables have been organized to present data that pertain to an individual parameter measured at a particular location. In all cases, the data in the tables show concentrations of the compound in the sampled air stream. Generally, measurements of source emission data are reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), while ambient and process exposure data are reported in nanograms per cubic meter (ng/m^3). All ambient concentrations are also presented in volume per volume units (e.g., ppbv). For those analytes which were not detected, the PQL is included in parenthesis. Blank spaces in a table indicate that the sample was not collected or the collected sample was invalid. A brief discussion follows of the tables containing results of the parameters sampled. Appendix F contains the flow calculation tables used to calculate the concentrations from the analytical data.

4.4.1 VOC Samples

A total of 615 VOC samples were collected: 271 at ambient locations, 206 at process exposure locations, and 138 at source locations. The VOC samples were analyzed for forty-three analytes. A total of seventeen of these analytes were never detected in any sample; Table 4.47 lists these compounds. For compounds detected, nineteen analytes were found at ambient locations, sixteen at process exposure locations, and twenty-five at source locations. Table 4.48 lists the analytes detected at each of these location types.

Sampling at ambient locations A12 and A13 was not possible on September 29, 1993, because of lawn maintenance activities around those locations. Process exposure locations P1, P2, and P8 on September 24, 1993; P10 on September 27, 1993; and source location S5-2 using a probe on September 24, 1993; were not sampled because of shortage of SUMMA canisters shipped by the laboratory. During Phase A, only two probe samples were conducted as planned at source locations that were scheduled for both probe and flux chamber sampling. The field GC results showed the expected absence of significant VOCs in these samples. The QA report (appendix M) identifies reasons for invalid samples. The VOC results from ambient sampling are presented at the end of this section in Table 4.51. Process and source sample results, as well as field GC results, are presented in appendix N.

4.4.2 SVOC Samples

A total of 602 SVOC samples (two hundred and sixty-nine at ambient locations, two hundred at process exposure locations, and one hundred and thirty-three at source locations) were collected. The SVOC samples were analyzed for eighty-four analytes. Fifty-eight of the analytes were never detected at any of the location types and are listed in Table 4.49. Table 4.50 compares the analytes found in one or more SVOC samples: thirteen analytes at ambient locations, twenty-four analytes at process exposure locations, and nine analytes at source locations were detected.

On September 27, 1993, ambient locations A5 and A8 were not sampled because of a shortage of PUF cartridges shipped by the laboratory. Sampling at ambient locations A12 and A13 was not possible on September 29, 1993, because of

lawn maintenance activities around these locations. Samples at A13 on October 13, 1993, and A9 on November 8, 1993, were invalidated because of loss of power to the sampler. None of the process locations was sampled on September 27, 1993, because of a shortage of PUF cartridges shipped by the laboratory. During Phase A, the third probe sample at source locations sampled by probes and flux chambers were not collected, as discussed for VOCs. The SVOC results for ambient stations are presented at the end of this section in Table 4.62. Process and source results are included in Appendix N.

4.4.3 Phenol Samples

A total of 609 phenol samples (271 at ambient locations, 210 at process exposure locations, and 128 at source locations) were collected. Sampling at ambient locations A12 and A13 was not possible on September 29, 1993, because of lawn maintenance activities around those locations. Samples A13 on October 13, 1993, and A9 on November 8, 1993, were considered invalid because of loss of power to the sampler. During Phase A, phenol samples were collected at source locations in accordance with the work plan. Phenol sample results are presented in Tables 4.53 through 4.57.

4.4.4 Formaldehyde Samples

A total of one hundred and seventy-three formaldehyde samples (sixty-three at ambient locations, fifty at process locations, and sixty at source locations) were collected. Formaldehyde samples were collected during Phase A, and for the first 2 days of Phase B. Sampling at ambient locations A12 and A13 was not possible on September 29, 1993, because of lawn maintenance activities around those locations. Results are listed in Tables 4.58 through 4.61 at the end of this section.

4.4.5 H₂S Samples

A total of one hundred and twenty-four H₂S samples were collected at seven ambient locations. All H₂S samples were analyzed as non-detects. The data in the tables represent PQL values. H₂S surveys were done at 15 process exposure locations using a Jerome analyzer. Blank spaces in the Jerome analyzer survey results table indicate that a survey was not done at that location. The results are listed in Tables 4.62 and 4.63.

4.4.6 VOC-Field GC

A total of 122 source samples were analyzed with the field GC. These samples were analyzed for ten target VOCs, based on preliminary data regarding presence in the waste streams. A total of fourteen compounds were tentatively identified in various samples, as listed in Table N.4 in appendix N; four of these were quantitated based on response factors for other compounds. The objectives of the field analysis were to verify sample times and loading for the standard sampling methods, evaluate proposed candidates for phase B sampling, and provide an indication of relative source strengths during the project.

4.4.7 TSP/Metals

A limited number (nine) samples were collected near the chemical mixing basin for total suspended particulate matter (TSP) and metals analysis. This sampling was not planned in the initial work plan, but was added in the beginning of the field effort. EPA's air quality reference method for TSP was used to collect the samples. These samples were taken to verify the absence of IWTP-based ambient air metals and other solid materials. The locations were selected to be near the possible sources to achieve the maximum sensitivity for analysis. The TSP and metals data are presented in Table 4.64.

4.4.8 Mercaptans

A number of bag samples were also collected around the chemical mixing and solids contact clarifier for organic sulfur compound analysis. Preliminary screening with a Jerome H₂S meter showed H₂S; bag samples were taken and analyzed by GC/MS for several mercaptans and organo-sulfides. None of these compounds were detected in the fourteen samples collected. Table 4.65 at the end of this section list the analytes and their PQLs.

Table 4.47
Analytes Never Detected by VOC Analysis at Source, Process, and
Ambient Locations
September – November 1993
Tinker AFB, Oklahoma

1,1,2,2–Tetrachloroethane
1,1,2–Trichloroethane
1,2–Dibromoethane (EDB)
1,2–Dichlorobenzene
1,2–Dichloroethane (EDC)
1,2–Dichloropropane
1,3–Butadiene
2–Chloroethyl Vinyl Ether
Bromodichloromethane
Bromoform
Bromomethane (Methyl Bromide)
Chloroethane (Ethyl Chloride)
Dibromochloromethane
Vinyl Acetate
cis–1,3–Dichloropropene
trans–1,2–Dichloroethene
trans–1,3–Dichloropropene

450RB/123r34/au401/voc_nd.wk3

Table 4.48
Analytes Detected by VOC Analysis at Either Source, Process, or
Ambient Locations
September – November 1993
Tinker AFB, Oklahoma

Analyte	Source	Process	Ambient
1,1,1–Trichloroethane (TCA)	•	•	•
1,1–Dichloroethane	•		
1,1–Dichloroethene	•		
1,3–Dichlorobenzene	•		
1,4–Dichlorobenzene	•	•	
2–Butanone (MEK)	•	•	•
2–Hexanone	•		
4–Methyl–2–Pentanone (MIBK)	•		•
Acetone	•	•	•
Benzene	•	•	•
Carbon Disulfide	•	•	•
Carbon Tetrachloride			•
Chlorobenzene	•		•
Chloroform	•		
Chloromethane (Methyl Chloride)	•	•	•
Dichloromethane	•	•	•
Ethylbenzene	•	•	•
Styrene	•		•
Tetrachloroethene (PCE)	•	•	•
Toluene	•	•	•
Trichloroethene (TCE)	•	•	•
Trichlorofluoromethane (F–11)	•	•	•
Trichlorotrifluoroethane (F–113)	•	•	•
Vinyl Chloride	•		
Xylenes	•	•	•
cis–1,2–Dichloroethene	•	•	•

450RB/123r34/au401/voc_d.wk3

Table 4.49
Analytes Not Detected by SVOC Analysis at Source, Process, and Ambient Locations
September – November 1993
Tinker AFB, Oklahoma

2,4,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dinitrophenol
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Methyl-4,6-dinitrophenol
2-Nitrophenol
3,3-Dichlorobenzidine
4-Bromophenylphenylether
4-Chlorophenylphenylether
Aldrin
Anthracene
Benzidine
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Butylbenzylphthalate
Chlordane
Chrysene
Cresols
Dibenzo(a,h)anthracene
Dieldrin
Dimethylphthalate
Endosulfan I
Endosulfan II
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
Methoxychlor
N-Nitrosodimethylamine
Nitrobenzene
PCB 1016
PCB 1221
PCB 1232
PCB 1242
PCB 1248
PCB 1254
PCB 1260
Toxaphene
alpha BHC
beta BHC
delta-BHC
gamma BHC (Lindane)
p,p'-DDD
p,p'-DDE
p,p'-DDT

Table 4.50
Analytes Detected by SVOC Analysis
Source, Process, or Ambient Locations
September – November 1993
Tinker AFB, Oklahoma

Analyte	Source	Process	Ambient
1,2,4–Trichlorobenzene	•	•	
1,2–Dichlorobenzene	•	•	•
1,3–Dichlorobenzene	•	•	•
1,4–Dichlorobenzene	•	•	•
2,4–Dimethylphenol	•		
2,4–Dinitrotoluene		•	
2–Chlorophenol		•	
4–Chloro–3–methylphenol		•	
4–Nitrophenol		•	
Acenaphthene		•	
Acenaphthylene		•	
Bis(2–chloroisopropyl)ether		•	
Bis(2–ethylhexyl)phthalate		•	•
Di–n–butylphthalate		•	•
Di–n–octylphthalate		•	•
Diethylphthalate		•	•
Fluoranthene		•	
Fluorene		•	
Methylnaphthalenes	•	•	•
N–Nitroso di–n–propylamine		•	•
N–Nitrosodiphenylamine		•	•
Naphthalene	•	•	•
Pentachlorophenol		•	
Phenanthrene		•	•
Phenol	•	•	•
Pyrene		•	

450RB/123r34/au401/svoc_d.wk3

Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/Mt	ppbv	µg/Mt	ppbv	µg/Mt	ppbv	µg/Mt	ppbv	µg/Mt	ppbv	µg/Mt	ppbv	µg/Mt	ppbv
Sample Date: 09/22/93														
1,1,1-Trichloroethane (TCA)	6.0	1.1	4.6	0.8	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	10.0	1.8	ND(1.0)	0.4
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3	36.0	12.0	ND(1.0)	0.3	ND(2.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	ND(0.5)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.2
Acetone	13.0	5.4	57.0	23.6	43.0	17.8	80.0	33.1	46.0	19.0	25.0	10.3	22.0	9.1
Benzene	ND(0.5)	0.2	20.0	6.2	ND(1.0)	0.3	ND(0.5)	0.2	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	16.0
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	1.6	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.5
Dichloromethane	130.0	35.9	590.0	163.1	28.0	7.7	21.0	5.8	26.0	7.2	27.0	7.5	33.0	9.1
Ethylbenzene	ND(1.0)	0.2	7.6	1.7	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	2.4	0.3	5.5	0.8	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3	ND(2.0)	0.3	1.3	0.2
Toluene	3.1	0.8	100.0	26.1	ND(2.0)	0.5	1.3	ND(2.0)	0.3	ND(2.0)	0.5	1.2	ND(0.5)	0.1
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	11.0	1.9	ND(1.0)	0.3	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	12.0	1.5	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	48.0	10.9	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2

Sample Date: 09/24/93

ND - Not detected; parenthetical value is PQL.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12+	A13+	
	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv
Sample Date: 09/27/93														
1,1,1-Trichloroethane (TCA)	7.3	1.3	7.3	1.3	3.2	0.6	ND(1.0)	0.2	ND(2.0)	0.4	ND(2.0)	0.4	2.6	0.5
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	3.2	ND(1.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Acetone	47.0	19.5	70.0	29.0	27.0	11.2	200.0	82.8	24.0	10.8	34.0	14.1	2200.0	11.6
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3	ND(1.0)	0.3	1.5	0.5
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	0.3
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.5	ND(1.0)	2.5	ND(1.0)	2.5	ND(0.5)	0.5
Dichloromethane	130.0	35.9	160.0	44.2	47.0	13.0	ND(5.0)	1.4	ND(10.0)	2.8	ND(10.0)	2.8	ND(10.0)	2.8
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.5
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5
Tetrachloroethene (PCE)	7.1	1.0	5.4	0.8	ND(1.0)	0.1	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	3.7	0.5
Toluene	6.8	1.8	5.9	1.5	3.2	0.8	ND(1.0)	0.3	3.3	0.9	4.8	0.9	6.2	1.3
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5
Xylenes	3.8	0.9	8.4	1.9	5.9	1.3	ND(1.0)	0.7	7.0	1.6	3.8	0.9	7.4	1.7
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5
Sample Date: 09/29/93														
1,1,1-Trichloroethane (TCA)	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	10.0	3.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Acetone	ND(3.0)	1.2	180.0	74.5	21.0	8.7	33.0	13.7	32.0	13.2	59.0	20.0	8.3	5.0
Benzene	ND(0.5)	0.2	ND(1.0)	0.3	ND(0.5)	0.2	ND(1.0)	0.3	0.8	0.2	0.9	0.7	12.0	2.3
Carbon Disulfide	ND(5.0)	1.6	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	ND(5.0)	1.4	ND(10.0)	2.8	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	8.4	2.3	100.0	27.6
Ethylbenzene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	ND(1.0)	0.3	ND(2.0)	0.5	2.0	0.5	ND(1.0)	0.3	1.7	0.4	1.2	0.3	2.5	0.7
Trichloroethene (TCE)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2

ND - Not detected, parenthetical value is POL.

+ - No data indicates sample not collected or invalid.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANAL YTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/M ₃	ppbv	µg/M ₃	ppbv	µg/M ₃	ppbv	µg/M ₃	ppbv	µg/M ₃	ppbv	µg/M ₃	ppbv	µg/M ₃	ppbv
Sample Date: 10/01/93														
1,1,1-Trichloroethane (TCA)	4.6	0.8	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.2	1.9	0.3
2-Butanone (MEK)	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	17.0	7.0	18.0	7.5	10.0	4.1	14.0	5.8	21.0	8.7	18.0	7.5	25.0	4.6
Benzene	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2
Carbon Disulfide	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6
Carbon Tetrachloride	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2
Chlorobenzene	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2
Dichloromethane	56.0	15.5	53.0	14.7	32.0	8.8	ND(10.0)	2.8	ND(10.0)	2.8	ND(10.0)	2.6	70.0	19.4
Ethylbenzene	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.2	ND(1.0)	0.5
Styrene	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.2	ND(1.0)	0.5
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.1	ND(1.0)	0.2
Toluene	ND(2.0)	0.5	1.7	0.4	ND(1.0)	0.3	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.4	2.2	0.6
Trichloroethene (TCE)	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.1	ND(0.5)	0.3
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3
Xylenes	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.2
Sample Date: 10/04/93														
1,1,1-Trichloroethane (TCA)	12.0	2.2	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	5.5	1.0
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(2.0)	0.4
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Acetone	21.0	8.7	50.0	20.7	17.0	7.0	24.0	9.9	39.0	16.1	42.0	17.4	16.0	31.5
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	76.0	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	140.0	38.7	38.0	10.5	14.0	3.9	ND(10.0)	2.8	10.0	2.8	ND(5.0)	1.4	79.0	21.8
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3
Toluene	2.9	0.8	2.0	0.5	2.0	2.3	4.3	0.6	4.4	1.1	2.4	0.4	1.6	2.1
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.5
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5

ND - Not detected, parenthetical value is PQL.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/Mi	ppmv	µg/Mi	ppmv	µg/Mi	ppmv	µg/Mi	ppmv	µg/Mi	ppmv	µg/Mi	ppmv	µg/Mi	ppmv
Sample Date: 10/07/93														
1,1,1-Trichloroethane (TCA)	8.4	1.5	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Acetone	17.0	7.0	20.0	8.3	27.0	11.2	22.0	9.1	30.0	12.4	1000.0	46.0	19.0	5.4
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5
Dichloromethane	170.0	47.0	24.0	6.6	16.0	4.4	10.0	2.8	ND(5.0)	1.4	6.5	8.9	2.5	130.0
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(2.0)	0.3
Toluene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.7	2.2	0.6	2.7	1.3	0.3	64.0
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5
Sample Date: 10/08/93														
1,1,1-Trichloroethane (TCA)	3.7	0.7	ND(2.0)	0.4	ND(5.0)	0.9	ND(2.0)	0.4	ND(1.0)	0.2	6.7	1.2	ND(2.0)	0.4
2-Butanone (MEK)	ND(1.0)	0.3	ND(2.0)	0.7	ND(5.0)	1.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(1.0)	0.2	ND(3.0)	0.7	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Acetone	13.0	5.4	110.0	45.5	1400.0	579.5	45.0	18.6	24.0	9.9	150.0	12.0	5.0	51.0
Benzene	ND(0.5)	0.2	ND(1.0)	0.3	ND(3.0)	0.9	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3
Carbon Disulfide	ND(5.0)	1.6	ND(10.0)	3.2	ND(30.0)	9.5	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	3.2
Carbon Tetrachloride	ND(1.0)	0.2	ND(2.0)	0.3	ND(5.0)	0.8	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.3
Chlorobenzene	ND(0.5)	0.1	ND(1.0)	0.2	ND(3.0)	0.6	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(1.0)	0.5	ND(3.0)	1.4	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5
Dichloromethane	80.0	22.1	17.0	4.7	ND(30.0)	8.3	ND(10.0)	2.8	5.9	1.6	37.0	10.2	10.8	12.0
Ethylbenzene	ND(1.0)	0.2	ND(2.0)	0.5	ND(5.0)	1.1	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Styrene	ND(1.0)	0.2	ND(2.0)	0.5	ND(5.0)	1.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Tetrachloroethene (PCE)	1.0	0.1	ND(2.0)	0.3	ND(5.0)	0.7	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.3
Toluene	2.8	0.7	2.5	0.7	ND(5.0)	1.3	ND(2.0)	0.5	ND(1.0)	0.3	7.3	1.9	0.5	21.1
Trichloroethene (TCE)	ND(0.5)	0.1	ND(1.0)	0.2	ND(3.0)	0.5	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(2.0)	0.3	ND(5.0)	0.9	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(4.0)	0.5	ND(10.0)	1.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(1.0)	0.2	ND(2.0)	0.5	ND(5.0)	1.1	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(2.0)	0.5	ND(5.0)	1.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5

ND - Not detected; parenthetical value is PQL.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/M3	ppbv	µg/M3	ppmv	µg/M3	ppmv	µg/M3	ppmv	µg/M3	ppmv	µg/M3	ppmv	µg/M3	ppmv
Sample Date: 10/12/93														
1,1,1-Trichloroethane (TCA)	8.6	1.5	5.1	0.9	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	1.2	0.2	ND(1.0)	0.4
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.2
Acetone	22.0	9.1	16.0	6.6	22.0	9.1	8.0	11.0	14.0	5.8	14.0	5.8	13.0	9.5
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.3	ND(0.5)	0.2	1.7	0.5	ND(0.5)	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.3
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5
Dichloromethane	110.0	30.4	80.0	22.1	24.0	6.6	ND(10.0)	2.8	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	2.8
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.1	1.9	0.3	ND(2.0)	0.4
Toluene	2.6	0.7	2.6	0.7	2.1	0.5	ND(2.0)	0.5	ND(1.0)	0.3	4.1	1.1	2.0	0.8
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.2
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	4.7	1.1	ND(2.0)	0.5	2.2	0.5	ND(1.0)	0.5	ND(1.0)	0.2	8.5	1.9	5.5	2.5
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Sample Date: 10/13/93														
1,1,1-Trichloroethane (TCA)	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	3.7	0.7	ND(2.0)	0.2
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	37.0	15.3	33.0	13.7	15.0	6.2	26.0	10.8	110.0	45.5	28.0	11.6	14.0	8.3
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	1.8	0.6	ND(1.0)	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.5	ND(1.0)	0.5	ND(0.5)	0.2
Dichloromethane	52.0	14.4	ND(10.0)	2.8	ND(5.0)	1.4	ND(5.0)	1.4	ND(10.0)	2.8	27.0	7.5	71.0	19.6
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1
Toluene	2.0	0.5	2.0	0.5	ND(1.0)	0.3	2.2	0.6	ND(2.0)	0.5	19.0	5.0	2.0	0.4
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.2	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	12.0	2.1	ND(2.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3
Xylenes	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2

ND - Not detected; parenthetical value is PQL.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv
Sample Date: 10/15/93														
1,1,1-Trichloroethane (TCA)	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2
2-Butanone (MEK)	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	5.7	1.9	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	17.0	7.0	19.0	7.9	25.0	10.3	150.0	62.1	18.0	7.5	15.0	6.2	110.0	45.5
Benzene	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	1.2	0.4	0.9	0.3	ND(0.5)	0.2	1.1	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	100.0	27.6	20.0	5.5	15.0	4.1	12.0	3.3	11.0	3.0	17.0	4.7	15.0	4.1
Ethylbenzene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	2.0	0.5	2.0	0.5	1.7	0.4	3.8	1.0	1.9	0.5	2.1	0.5	2.1	0.5
Trichloroethene (TCE)	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Sample Date: 10/18/93														
1,1,1-Trichloroethane (TCA)	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Acetone	15.0	6.2	36.0	14.9	7.1	2.9	35.0	14.5	1.1	1.2	14.0	5.8	9.3	3.8
Benzene	1.9	0.6	1.8	0.6	ND(0.5)	0.2	ND(1.0)	0.3	ND(0.5)	0.2	1.6	0.5	1.7	0.5
Carbon Disulfide	ND(5.0)	1.6	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Diethylmethane	31.0	8.6	ND(10.0)	2.8	ND(5.0)	1.4	ND(10.0)	2.8	ND(5.0)	1.4	ND(0.5)	0.2	ND(0.5)	0.2
Ethylbenzene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	5.6	1.5	3.7	1.0	3.7	1.0	4.3	1.1	ND(1.0)	0.3	ND(1.0)	0.3	3.7	1.0
Trichloroethene (TCE)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2

ND - Not detected; parenthetical value is PQL.

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations																									
	A1		A2		A3		A4		A5		A6		A7		A8		A9		A10		A11		A12		A13	
	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv	µg/Mi	ppbv
Sample Date: 10/20/93																										
1,1,1-Trichloroethane (TCA)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Acetone	16.0	6.6	20.0	8.3	19.0	7.9	58.0	24.0	160.0	12	66.2	9.1	24.0	17.0	9.9	17.0	7.0	7.0	7.0	7.0	7.6	3.1	22.0	9.1	41.0	17.0
Benzene	1.3	0.4	ND(0.5)	0.2	ND(0.5)	0.2	1.5	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	1.4	0.4	1.7	0.5	ND(0.5)	0.2	1.1	0.3	ND(0.5)	0.2	9.1	2.8
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	26.0	7.2	26.0	62.0	71.0	19.6	14	36.0	14	14	14	14	36.0	14	36.0	14	10.0	10.0
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	3.7	0.8
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	6.0	1.4
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	2.5	0.7	2.4	0.6	7.6	2.0	2.4	0.6	3.2	15.0	3.9	4.0	3.1	4.6	2.2	120.0	31.3	0.6	120.0	31.3	0.6	120.0	31.3	0.6	120.0	31.3
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	17.0	3.0
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	18.0	4.1
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Sample Date: 10/25/93																										
1,1,1-Trichloroethane (TCA)	5.3	1.0	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2	ND(2.0)	0.4
2-Butanone (MEK)	ND(1.0)	0.3	7.5	2.5	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3	ND(2.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Acetone	15.0	6.2	19.0	7.9	20.0	8.3	13.0	5.4	16.0	6.6	16.0	17.0	7.0	22.0	9.1	ND(3.0)	1.2	29.0	12.0	72.0	29.8	ND(3.0)	1.2	6.3	2.6	
Benzene	1.3	0.4	2.4	0.7	2.1	0.6	ND(0.5)	0.2	1.8	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3	ND(0.5)	0.2	ND(1.0)	0.3	
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5
Dichloromethane	130.0	35.9	30.0	8.3	11.0	3.0	ND(5.0)	1.4	7.4	2.0	3.3	19.0	5.3	30.0	8.3	ND(5.0)	1.4	41.0	11.3	80.0	22.1	ND(5.0)	1.4	48.0	13.3	
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	3.2	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3
Toluene	3.9	1.0	6.3	1.6	4.9	1.3	4.0	1.0	4.1	1.1	3.0	3.2	0.8	2.4	0.6	ND(0.5)	0.3	2.3	0.6	5.2	1.4	ND(0.5)	0.3	2.8	0.7	
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	3.9	1.0	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5

* - Not detected, reported value is PQL.

4508B/72144 rev_1020w43

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANAL YTE	Station Locations																									
	A1	ppbv	A2	ppbv	A3	ppbv	A4	ppbv	A5	ppbv	A6	ppbv	A7	ppbv	A8	ppbv	A9	ppbv	A10	ppbv	A11	ppbv	A12	ppbv	A13	ppbv
Sample Date: 10/27/93																										
1,1,1-Trichloroethane (TCA)	2.7	0.5	ND(1.0)	0.2	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(2.0)	0.4
2-Butanone (MEK)	ND(2.0)	0.7	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(2.0)	0.7	ND(1.0)	0.3	ND(2.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Acetone	16.0	6.6	19.0	7.9	21.0	8.7	16.0	6.6	19.0	7.9	9.7	4.0	ND(3.0)	1.2	20.0	8.3	15.0	6.2	22.0	9.1	27.0	11.2	15.0	6.2	16.0	6.6
Benzene	ND(1.0)	0.3	ND(0.5)	0.2	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(1.0)	0.3
Carbon Disulfide	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3
Chlorobenzene	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Chloromethane (Methyl Chloride)	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(1.0)	0.5	ND(0.5)	0.2	ND(1.0)	0.5
Dichloromethane	130.0	35.9	43.0	11.9	11.0	3.0	ND(10.0)	2.8	ND(10.0)	2.8	7.3	2.0	ND(5.0)	1.4	ND(10.0)	2.8	ND(10.0)	2.8	ND(10.0)	2.8	87.0	24.1	ND(5.0)	1.4	ND(10.0)	2.8
Ethylbenzene	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Styrene	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Tetrachloroethene (PCE)	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(1.0)	0.1	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3
Toluene	2.2	0.6	2.7	0.7	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	1.6	0.4	ND(1.0)	0.3	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	2.1	0.5	1.4	0.4	ND(2.0)	0.5
Trichloroethene (TCE)	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(1.0)	0.2
Trichlorofluoroethane (F-11)	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(2.0)	0.3
Trichlorotrifluoroethane (F-113)	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.3	ND(4.0)	0.5
Xylenes	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
cis-1,2-Dichloroethene	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5
Sample Date: 10/29/93																										
1,1,1-Trichloroethane (TCA)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	1.0	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Acetone	54.0	22.4	ND(2.0)	0.8	10.0	4.1	22.0	9.1	13.0	5.4	9.9	4.1	64.0	26.5	16.0	6.6	21.0	8.7	6.3	2.6	210.0	86.9	12.0	5.0	14.0	5.8
Benzene	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	5.7	1.6	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	9.0	2.5	25.0	6.9	33.0	9.1	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4	ND(5.0)	1.4
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	2.5	0.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.4	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoroethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2

ND - Not detected; parenthetical value is PQL.

450R072141m_1027.m3

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv
1,1,1-Trichloroethane (TCA)	5.5	1.0	ND(1.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.7	ND(1.0)	0.3	ND(1.0)	3.7	ND(1.0)	3.7
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.1	ND(0.5)	0.2	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1
Acetone	69.0	28.6	96.0	39.7	11.0	7.0	17.0	5.8	16.0	6.6	44.0	18.2	51.0	23.2
Benzene	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.3	ND(0.5)	0.3	ND(1.0)	0.3	ND(0.5)	0.2	ND(0.5)	0.2
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(5.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.5	ND(1.0)	0.2	ND(0.5)	0.5	ND(1.0)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	140.0	38.7	9.9	2.7	ND(10.0)	1.4	ND(10.0)	2.8	12.0	3.3	7.0	51.0	14.1	32.0
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.5	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2
Tetrachloroethene (PCE)	9.4	1.4	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.8	1.1	0.2
Toluene	1.5	0.4	ND(1.0)	0.3	ND(2.0)	0.5	ND(1.0)	0.4	ND(2.0)	0.5	ND(1.0)	0.3	ND(1.0)	0.3
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.5	ND(4.0)	0.5	ND(4.0)	0.5	ND(2.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	ND(1.0)	0.5	ND(2.0)	0.2	ND(1.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Sample Date: 11/02/93														
1,1,1-Trichloroethane (TCA)	2.3	0.4	ND(2.0)	0.4	ND(2.0)	0.4	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(2.0)	0.7	ND(2.0)	1.0	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.7
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.2
Acetone	26.0	10.8	9.0	3.7	35.0	14.5	13.0	5.4	7.5	3.1	78.0	66.0	27.3	540.0
Benzene	2.4	0.7	ND(1.0)	0.3	ND(1.0)	0.2	2.7	0.8	2.5	0.8	2.5	1.9	0.6	0.3
Carbon Disulfide	ND(5.0)	1.6	ND(10.0)	3.2	ND(10.0)	3.2	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2
Carbon Tetrachloride	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(1.0)	0.2	ND(1.0)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.2
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.2	ND(1.0)	0.5
Dichloromethane	25.0	6.9	34.0	9.4	29.0	13.0	9.2	3.6	5.4	1.5	71.0	10.0	2.8	2.8
Ethylbenzene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.5
Styrene	ND(1.0)	0.2	ND(2.0)	0.5	ND(2.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5
Tetrachloroethene (PCE)	9.6	1.4	ND(2.0)	0.3	ND(2.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	23.0	11.0	6.1	0.9
Toluene	5.8	1.5	8.0	2.1	8.5	5.7	5.2	1.5	6.1	1.4	4.3	4.3	1.1	1.0
Trichloroethene (TCE)	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.3	ND(4.0)	0.5
Xylenes	1.6	0.4	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	1.6	2.9	0.7	1.5	0.3	ND(2.0)	0.5
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.5

ND - Not detected; parenthetical value is PQL.

459RB7214H16w_1101.mh3

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv	µg/Ms	ppbv
1,1,1-Trichloroethane (TCA)	2.6	0.5	ND(1.0)	0.2	ND(1.0)	0.2	1.0	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	7.0	2.9	6.0	2.5	14.0	5.8	13.0	3.4	6.1	2.5	3.4	1.4	3.6	1.5
Benzene	ND(0.5)	0.2	1.2	0.4	ND(0.5)	0.2	ND(0.5)	0.2	0.8	0.2	0.8	0.2	1.1	0.3
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	55.0	15.2	8.1	2.2	ND(5.0)	1.4	ND(5.0)	2.1	10.0	2.8	ND(5.0)	1.4	ND(5.0)	1.4
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	4.7	0.7	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	2.8	0.7	2.2	0.6	1.7	0.4	1.5	0.4	ND(1.0)	0.3	2.8	0.7	1.3	1.0
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	1.0	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Sample Date: 11/06/93														
1,1,1-Trichloroethane (TCA)	2.6	0.5	ND(1.0)	0.2	ND(1.0)	0.2	1.0	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2
2-Butanone (MEK)	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	7.0	2.9	6.0	2.5	14.0	5.8	13.0	3.4	6.1	2.5	3.4	1.4	3.6	1.5
Benzene	ND(0.5)	0.2	1.2	0.4	ND(0.5)	0.2	ND(0.5)	0.2	0.8	0.2	0.8	0.2	1.1	0.3
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2
Dichloromethane	55.0	15.2	8.1	2.2	ND(5.0)	1.4	ND(5.0)	2.1	10.0	2.8	ND(5.0)	1.4	ND(5.0)	1.4
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Tetrachloroethene (PCE)	4.7	0.7	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1
Toluene	2.8	0.7	2.2	0.6	1.7	0.4	1.5	0.4	ND(1.0)	0.3	2.8	0.7	1.3	1.0
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3
Xylenes	1.0	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2

ND - Not detected; parenthetical value is PQL.

430RB/22141/rev_1104.mw3

Table 4.51 (continued)
Ambient VOC Concentrations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	µg/M ³	ppbv	µg/M ³	ppbv	µg/M ³	ppbv	µg/M ³	ppbv	µg/M ³	ppbv	µg/M ³	ppbv	µg/M ³	ppbv
1,1,1-Trichloroethane (TCA)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.4	ND(1.0)	0.2
2-Butanone (MEK)	20.0	6.7	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(1.0)	0.3	ND(2.0)	0.7	ND(1.0)	0.3
4-Methyl-2-Pentanone (MIBK)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Acetone	84.0	34.8	40.0	16.6	12.0	5.0	46.0	19.0	11.0	4.6	9.9	4.1	12.0	5.0
Benzene	ND(0.5)	0.2	ND(0.5)	0.2	1.6	0.5	1.8	0.6	1.5	0.5	ND(0.5)	0.2	ND(0.5)	0.2
Carbon Disulfide	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(5.0)	1.6	ND(10.0)	3.2	ND(5.0)	1.6
Carbon Tetrachloride	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2
Chlorobenzene	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1
Chloromethane (Methyl Chloride)	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(0.5)	0.2	ND(1.0)	0.5	ND(0.5)	0.2
Dichloromethane	71.0	19.6	9.3	2.6	6.4	1.8	ND(5.0)	1.4	ND(5.0)	1.4	ND(1.0)	9.4	12.0	2.2
Ethylbenzene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2
Styrene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2
Tetrachloroethene (PCE)	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(1.0)	0.1	ND(2.0)	0.3	ND(1.0)	0.1
Toluene	ND(1.0)	0.3	2.2	0.6	2.3	0.6	2.0	0.5	1.9	0.4	ND(2.0)	0.5	ND(1.0)	0.3
Trichloroethene (TCE)	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(0.5)	0.1	ND(1.0)	0.2	ND(0.5)	0.1
Trichlorofluoromethane (F-11)	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.3	ND(1.0)	0.2
Trichlorotrifluoroethane (F-113)	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(2.0)	0.3	ND(4.0)	0.5	ND(2.0)	0.3
Xylenes	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2
cis-1,2-Dichloroethene	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(1.0)	0.2	ND(2.0)	0.5	ND(1.0)	0.2

ND - Not detected; parthenical value is PQL.

Table 4.52
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations																										
	A1		A2		A3		A4		A5		A6		A7		A8		A9		A10		A11		A12		A13		
	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	
Sample Date: 09/22/93																											
1,2-Dichlorobenzene	ND(16.9)	2.8	29.8	4.9	41.2	6.7	ND(16.3)	2.7	ND(16.0)	2.6	32.4	5.3	ND(16.4)	2.7	28.4	4.6	ND(16.6)	2.7	ND(15.9)	2.6	79.9	13.1	22.5	3.7	31.7	5.2	
1,3-Dichlorobenzene	ND(16.9)	2.8	ND(17.0)	2.8	ND(17.2)	2.8	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.2)	2.7	ND(16.4)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(15.9)	2.6	ND(16.6)	2.7	ND(16.6)	2.7	ND(16.5)	2.7	
1,4-Dichlorobenzene	ND(16.9)	2.8	ND(17.0)	2.8	19.9	3.3	ND(16.3)	2.7	ND(16.0)	2.6	19.8	3.2	ND(16.4)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(15.9)	2.6	30.0	4.9	ND(16.6)	2.7	ND(16.5)	2.7	
Bis(2-ethylhexyl)phthalate	ND(16.9)	1.0	ND(17.0)	1.0	25.4	1.6	ND(16.3)	1.0	25.6	1.6	27.2	1.7	17.7	1.1	24.4	1.5	ND(16.6)	1.0	21.3	1.3	26.6	1.6	ND(16.6)	1.0	138.8	8.5	
Di-n-butylphthalate	37.2	3.2	88.2	7.6	140.7	12.1	19.6	1.7	102.4	8.8	168.5	14.6	78.7	6.8	148.3	12.8	46.5	4.0	108.3	9.4	109.9	9.5	89.4	7.7	89.2	7.7	
Di-n-octylphthalate	ND(16.9)	1.0	ND(17.0)	1.1	ND(17.2)	1.1	ND(16.3)	1.0	ND(16.0)	1.0	ND(16.2)	1.0	ND(16.4)	1.0	ND(16.5)	1.0	ND(16.6)	1.0	ND(15.9)	1.0	ND(16.6)	1.0	ND(16.6)	1.0	ND(16.5)	1.0	
Diethylphthalate	ND(16.9)	1.8	18.3	2.0	33.6	3.6	ND(16.3)	1.8	21.4	2.3	20.4	2.2	30.2	3.3	27.0	2.9	ND(16.6)	1.8	17.2	1.9	30.3	3.3	ND(16.6)	1.8	ND(16.5)	1.8	
Methylnaphthalenes	22.7	3.8	88.2	14.9	96.1	16.2	ND(16.3)	2.8	57.6	9.7	97.2	16.4	49.2	8.3	72.5	12.3	ND(16.6)	2.8	60.5	10.2	163.1	27.6	79.5	13.4	89.2	15.1	
N-Nitroso di-n-propylamine	ND(16.9)	3.1	ND(17.0)	3.1	ND(17.2)	3.2	ND(16.3)	3.0	ND(16.0)	3.0	ND(16.2)	3.0	ND(16.4)	3.0	ND(16.5)	3.0	ND(16.6)	3.1	ND(15.9)	2.9	ND(16.6)	3.1	ND(16.6)	3.1	ND(16.5)	3.1	
N-Nitrosodiphenylamine	ND(16.9)	2.1	ND(17.0)	2.1	ND(17.2)	2.1	ND(16.3)	2.0	ND(16.0)	1.9	ND(16.2)	2.0	ND(16.4)	2.0	ND(16.5)	2.0	ND(16.6)	2.0	ND(15.9)	1.9	ND(16.6)	2.0	ND(16.6)	2.0	ND(16.5)	2.0	
Naphthalene	21.0	3.9	81.4	15.3	102.9	19.3	ND(16.3)	3.1	60.8	11.4	110.2	20.7	45.9	8.6	72.5	13.6	ND(16.6)	3.1	60.5	11.4	169.8	31.8	72.9	13.7	109.1	20.5	
Phenanthrene	ND(16.9)	2.3	ND(17.0)	2.3	ND(17.2)	2.3	ND(16.3)	2.2	ND(16.0)	2.2	20.1	2.7	20.3	2.7	27.0	3.6	ND(16.6)	2.2	24.2	3.3	17.3	2.3	ND(16.6)	2.2	ND(16.5)	2.2	
Phenol	ND(16.9)	4.3	47.5	12.1	65.2	16.6	16.7	4.3	41.6	10.6	77.8	19.9	114.7	29.3	240.6	61.5	ND(16.6)	4.2	89.2	22.8	119.9	30.6	27.2	6.9	46.3	11.8	
Sample Date: 09/24/93																											
1,2-Dichlorobenzene	55.1	9.0	ND(16.5)	2.7	ND(14.3)	2.3	ND(16.4)	2.7	ND(16.1)	2.6	ND(16.3)	2.7	18.1	3.0	24.8	4.1	23.2	3.8	49.4	8.1	17.8	2.9	ND(15.5)	2.5	ND(15.4)	2.5	
1,3-Dichlorobenzene	ND(16.2)	2.6	ND(16.5)	2.7	ND(14.3)	2.3	ND(16.4)	2.7	ND(16.1)	2.6	ND(16.3)	2.7	ND(15.6)	2.6	ND(15.7)	2.6	ND(15.9)	2.6	ND(15.5)	2.5	ND(16.2)	2.6	ND(15.5)	2.5	ND(15.4)	2.5	
1,4-Dichlorobenzene	20.4	3.3	ND(16.5)	2.7	ND(14.3)	2.3	ND(16.4)	2.7	ND(16.1)	2.6	ND(16.3)	2.7	ND(15.6)	2.6	ND(15.7)	2.6	ND(15.9)	2.6	16.4	2.7	ND(16.2)	2.6	ND(15.5)	2.5	ND(15.4)	2.5	
Bis(2-ethylhexyl)phthalate	ND(16.2)	1.0	ND(16.5)	1.0	37.1	2.3	42.7	2.6	22.2	1.4	24.2	1.5	16.8	1.0	31.4	1.9	ND(15.9)	1.0	29.0	1.8	ND(16.2)	1.0	34.1	2.1	17.3	1.1	
Di-n-butylphthalate	149.0	12.9	138.3	11.9	114.1	9.9	62.4	5.4	106.0	9.2	202.7	17.5	99.8	8.6	169.8	14.7	136.7	11.8	111.3	9.6	84.1	7.3	102.2	8.8	181.9	15.7	
Di-n-octylphthalate	ND(16.2)	1.0	ND(16.5)	1.0	ND(14.3)	0.9	ND(16.4)	1.0	ND(16.1)	1.0	ND(16.3)	1.0	ND(15.6)	1.0	ND(15.7)	1.0	ND(15.9)	1.0	ND(15.5)	1.0	ND(16.2)	1.0	ND(15.5)	1.0	ND(15.4)	0.9	
Diethylphthalate	93.9	10.2	69.2	7.5	62.8	6.8	52.5	5.7	31.2	3.4	31.7	3.4	37.4	4.0	27.4	3.0	ND(15.9)	1.7	37.1	4.0	29.1	3.1	ND(15.5)	1.7	ND(15.4)	1.7	
Methylnaphthalenes	97.2	16.4	85.6	14.5	48.5	8.2	49.2	8.3	57.8	9.8	55.6	9.4	34.3	5.8	56.6	9.6	63.6	10.7	98.9	16.7	51.7	8.7	46.4	7.9	33.9	5.7	
N-Nitroso di-n-propylamine	ND(16.2)	3.0	ND(16.5)	3.0	ND(14.3)	2.6	ND(16.4)	3.0	ND(16.1)	3.0	ND(16.3)	3.0	ND(15.6)	2.9	ND(15.7)	2.9	ND(15.9)	2.9	ND(15.5)	2.9	ND(16.2)	3.0	ND(15.5)	2.9	ND(15.4)	2.8	
N-Nitrosodiphenylamine	ND(16.2)	2.0	ND(16.5)	2.0	ND(14.3)	1.7	ND(16.4)	2.0	ND(16.1)	1.9	ND(16.3)	2.0	ND(15.6)	1.9	ND(15.7)	1.9	ND(15.9)	1.9	ND(15.5)	1.9	ND(16.2)	2.0	ND(15.5)	1.9	ND(15.4)	1.9	
Naphthalene	106.9	20.0	95.5	17.9	54.2	10.2	55.8	10.5	67.5	12.7	58.9	11.0	37.4	7.0	59.7	11.2	66.7	12.5	105.1	19.7	55.0	10.3	65.0	12.2	37.0	6.9	
Phenanthrene	ND(16.2)	2.2	ND(16.5)	2.2	ND(14.3)	1.9	ND(16.4)	2.2	16.4	2.2	16.3	2.2	ND(15.6)	2.1	ND(15.7)	2.1	ND(15.9)	2.1	ND(15.5)	2.1	ND(16.2)	2.2	ND(15.5)	2.1	ND(15.4)	2.1	
Phenol	453.4	115.8	82.3	21.0	21.7	5.5	19.0	4.9	32.1	8.2	98.1	25.1	374.4	95.6	267.2	68.3	206.6	52.8	231.8	59.2	155.2	39.7	49.5	12.7	30.8	7.9	

ND - Not detected; parenthetical value is PQL.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations																										
	A1		A2		A3		A4		A5+		A6		A7		A8+		A9		A10		A11		A12+		A13+		
	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	
Sample Date: 09/27/93																											
1,2-Dichlorobenzene	ND(169.9)	27.8	213.4	34.9	43.7	7.2	18.3	3.0	ND(17.1)	2.8	ND(17.0)	2.8	ND(17.1)	2.8	ND(17.0)	2.8	48.7	8.0	64.4	10.5	33.8	5.5	116.6	19.1	129.4	21.2	
1,3-Dichlorobenzene	ND(169.9)	27.8	ND(172.1)	28.1	ND(16.8)	2.8	ND(17.0)	2.8	ND(17.1)	2.8	ND(17.0)	2.8	ND(17.1)	2.8	ND(16.9)	2.8	ND(17.4)	2.8	ND(16.9)	2.8	ND(16.9)	2.8	ND(17.1)	2.8	ND(20.9)	3.4	
1,4-Dichlorobenzene	ND(169.9)	27.8	ND(172.1)	28.1	18.2	3.0	ND(17.0)	2.8	ND(17.1)	2.8	ND(17.0)	2.8	ND(17.1)	2.8	ND(16.9)	2.8	ND(17.4)	2.8	ND(16.9)	2.8	ND(16.9)	2.8	ND(17.1)	2.8	ND(20.9)	3.4	
Bis(2-ethylhexyl)phthalate	ND(169.9)	10.5	ND(172.1)	10.6	22.9	1.4	23.7	1.5	ND(17.1)	1.1	20.4	1.3	ND(17.1)	1.1	ND(16.9)	1.1	ND(17.4)	1.1	ND(16.9)	1.0	47.3	2.9	ND(17.1)	1.1	ND(20.9)	1.3	
Di-n-butylphthalate	197.1	17.0	ND(172.1)	14.9	245.6	21.2	196.7	17.0	122.9	10.6	119.1	10.3	94.8	10.8	8.2	165.5	14.3	140.6	12.1	140.6	14.3	140.6	12.1	242.2	20.9		
Di-n-octylphthalate	ND(169.9)	10.5	ND(172.1)	10.6	ND(16.8)	1.0	ND(17.0)	1.0	ND(17.1)	1.1	ND(17.0)	1.0	ND(16.9)	1.1	ND(16.9)	1.0	ND(17.4)	1.1	ND(16.9)	1.0	ND(16.9)	1.0	ND(17.1)	1.1	ND(20.9)	1.3	
Diethylphthalate	ND(169.9)	18.4	ND(172.1)	18.6	ND(16.8)	1.8	ND(17.0)	1.8	ND(17.1)	1.8	ND(17.0)	1.8	ND(17.1)	1.8	ND(16.9)	1.8	ND(17.4)	1.9	ND(16.9)	1.8	ND(16.9)	1.8	ND(17.1)	1.9	ND(20.9)	2.3	
Methylphthalates	849.7	143.6	1411.4	238.6	269.1	45.5	101.8	17.2	99.0	16.7	68.1	11.5	107.8	18.2	91.5	15.5	107.8	18.2	91.5	15.5	439.1	74.2	116.6	19.7	66.8	11.3	
N-Nitroso di-n-propylamine	ND(169.9)	31.4	ND(172.1)	31.8	ND(16.8)	3.1	ND(17.0)	3.1	ND(17.1)	3.2	ND(17.0)	3.1	ND(16.9)	3.1	ND(16.9)	3.1	ND(17.4)	3.2	ND(16.9)	3.1	ND(16.9)	3.1	ND(17.1)	3.2	ND(20.9)	3.9	
N-Nitrosodiphenylamine	ND(169.9)	20.6	ND(172.1)	20.9	ND(16.8)	2.0	ND(17.0)	2.1	ND(17.1)	2.1	ND(17.0)	2.1	ND(16.9)	2.1	ND(16.9)	2.1	ND(17.4)	2.1	ND(16.9)	2.1	ND(16.9)	2.1	ND(17.1)	2.1	ND(20.9)	2.5	
Naphthalene	543.8	102.0	963.9	180.8	198.5	37.2	95.0	17.8	116.1	21.8	71.5	13.4	118.2	22.2	111.8	21.0	118.2	22.2	111.8	21.0	277.0	51.9	113.2	21.2	62.6	11.7	
Phenanthrene	ND(169.9)	22.9	ND(172.1)	23.2	ND(16.8)	2.3	ND(17.0)	2.3	17.1	2.3	ND(17.0)	9.6	38.2	9.8	44.0	11.2	38.2	9.8	44.0	11.2	246.6	2.3	ND(17.1)	2.3	ND(20.9)	2.8	
Phenol	849.7	217.0	1376.9	351.7	218.7	55.9	108.5	27.7	ND(17.1)	4.4	37.4	9.6	38.2	9.8	44.0	11.2	38.2	9.8	44.0	11.2	246.6	63.0	92.6	23.6	121.1	30.9	

Sample Date: 09/29/93

1,2-Dichlorobenzene	32.2	5.3	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(19.3)	3.2	ND(16.1)	2.6	107.0	17.5	ND(16.5)	2.7	
1,3-Dichlorobenzene	ND(16.8)	2.7	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(19.3)	3.2	ND(16.1)	2.6	23.7	3.9	ND(16.5)	2.7	
1,4-Dichlorobenzene	ND(16.8)	2.7	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(19.3)	3.2	ND(16.1)	2.6	ND(16.2)	2.7	ND(16.5)	2.7	
Bis(2-ethylhexyl)phthalate	940.3	57.9	3388.8	45.7	186.0	2.8	2590.3	159.4	1608.9	99.0	3362.4	207.0	83.1	3323.4	204.6	1739.0	107.0	1783.3	109.8	122.4	1.4	122.4	1.4	ND(16.5)	1.0
Di-n-butylphthalate	73.9	6.4	ND(16.9)	1.5	ND(16.3)	1.0	99.6	8.6	28.8	2.5	ND(16.8)	1.5	ND(16.6)	7.2	ND(19.3)	1.7	ND(16.1)	1.4	ND(16.2)	1.4	ND(16.2)	1.4	ND(16.5)	1.0	
Di-n-octylphthalate	ND(16.8)	1.0	ND(16.9)	1.0	ND(16.3)	1.0	ND(16.6)	1.0	ND(16.8)	1.0	ND(16.8)	1.0	ND(16.6)	1.0	ND(19.3)	1.2	ND(16.1)	1.0	ND(16.2)	1.0	ND(16.2)	1.0	ND(16.5)	1.0	
Diethylphthalate	ND(16.8)	1.8	ND(16.9)	1.8	ND(16.3)	1.8	43.2	4.7	ND(16.8)	1.8	ND(16.8)	1.8	ND(16.6)	1.8	ND(19.3)	2.1	ND(16.1)	1.7	ND(16.2)	1.7	ND(16.2)	1.8	ND(16.5)	1.8	
Methylphthalates	127.6	21.6	64.4	10.9	39.2	6.6	36.5	6.2	46.9	7.9	43.7	7.4	19.3	3.3	30.9	5.2	45.1	7.6	356.7	3.0	356.7	60.3	32.4	5.5	
N-Nitroso di-n-propylamine	ND(16.8)	3.1	ND(16.9)	3.1	ND(16.3)	3.0	ND(16.6)	3.1	ND(16.8)	3.1	ND(16.8)	3.1	ND(16.6)	3.1	ND(19.3)	3.6	ND(16.1)	3.0	ND(16.2)	3.0	ND(16.2)	3.0	ND(16.5)	3.1	
N-Nitrosodiphenylamine	ND(16.8)	2.0	ND(16.9)	2.1	ND(16.3)	2.0	ND(16.6)	2.0	ND(16.8)	2.0	ND(16.8)	2.0	ND(16.6)	2.0	ND(19.3)	2.3	ND(16.1)	2.0	ND(16.2)	2.0	ND(16.2)	2.0	ND(16.5)	2.0	
Naphthalene	73.9	13.9	44.1	8.3	28.4	5.3	29.2	5.5	40.2	7.5	37.0	6.9	18.3	3.4	22.4	4.2	29.3	5.5	207.5	38.9	29.8	5.6	29.8	5.6	
Phenanthrene	ND(16.8)	2.3	ND(16.9)	2.3	ND(16.3)	2.2	ND(16.6)	2.2	ND(16.8)	2.3	ND(16.8)	2.3	ND(16.6)	2.2	ND(19.3)	2.6	ND(16.1)	2.2	ND(16.2)	2.2	ND(16.2)	2.2	ND(16.5)	2.2	
Phenol	124.3	31.7	40.7	10.4	ND(16.3)	4.2	ND(16.6)	4.2	ND(16.8)	4.3	ND(16.8)	4.3	ND(16.6)	4.2	ND(19.3)	4.9	48.3	12.3	356.7	91.1	356.7	91.1	ND(16.5)	4.2	

ND - Not detected; parenthetical value is POL.

+ - No data indicates sample not collected or invalid.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations											
	A1		A2		A3		A4		A5		A6	
	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv
Sample Date: 10/01/93												
1,2-Dichlorobenzene	31.8	5.2	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.2)	2.6	ND(16.6)	2.7
1,3-Dichlorobenzene	ND(16.2)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.2)	2.6	ND(16.6)	2.7
1,4-Dichlorobenzene	ND(16.2)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.2)	2.6	ND(16.6)	2.7
Bis(2-ethylhexyl)phthalate	2497.6	153.7	688.1	42.4	784.2	48.3	910.8	56.1	1101.9	67.8	565.2	34.8
Di-n-butylphthalate	ND(16.2)	1.4	18.4	1.6	16.3	1.4	ND(16.3)	1.4	ND(16.2)	1.4	ND(16.6)	1.4
Di-n-octylphthalate	ND(16.2)	1.0	ND(16.4)	1.0	ND(16.3)	1.0	ND(16.3)	1.0	ND(16.2)	1.0	ND(16.6)	1.0
Diethylphthalate	ND(16.2)	1.8	29.5	3.2	ND(16.3)	1.8	ND(16.3)	1.8	ND(16.2)	1.8	ND(16.6)	1.8
Methylisophthalates	279.0	47.2	101.6	17.2	29.4	5.0	31.2	5.3	24.3	4.1	36.6	6.2
N-Nitroso di-n-propylamine	ND(16.2)	3.0	ND(16.4)	3.0	ND(16.3)	3.0	ND(16.3)	3.0	ND(16.2)	3.0	ND(16.6)	3.1
N-Nitrosodiphenylamine	ND(16.2)	2.0	ND(16.4)	2.0	ND(16.3)	2.0	ND(16.3)	2.0	ND(16.2)	2.0	ND(16.6)	2.0
Naphthalene	139.5	26.2	55.7	10.4	ND(16.3)	3.1	30.6	5.7	24.6	4.6	30.3	5.7
Phenanthrene	ND(16.2)	2.2	ND(16.4)	2.2	ND(16.3)	2.2	ND(16.3)	2.2	ND(16.2)	2.2	ND(16.6)	2.2
Phenol	129.7	33.1	36.0	9.2	ND(16.3)	4.2	ND(16.3)	4.2	ND(16.2)	4.1	ND(16.6)	4.2
Sample Date: 10/04/93												
1,2-Dichlorobenzene	67.4	11.0	28.4	4.6	61.1	10.0	ND(16.6)	2.7	ND(18.2)	3.0	ND(16.7)	2.7
1,3-Dichlorobenzene	ND(16.9)	2.8	ND(17.1)	2.8	ND(17.0)	2.8	ND(16.6)	2.7	ND(18.2)	3.0	ND(16.7)	2.7
1,4-Dichlorobenzene	20.2	3.3	30.5	5.0	22.1	3.6	ND(16.6)	2.7	ND(18.2)	3.0	ND(16.7)	2.7
Bis(2-ethylhexyl)phthalate	ND(16.9)	1.0	ND(17.1)	1.1	ND(17.0)	1.0	ND(16.6)	1.0	ND(18.2)	1.1	ND(16.7)	1.0
Di-n-butylphthalate	77.5	6.7	47.9	4.1	67.8	5.9	33.1	2.9	58.4	5.0	60.2	5.2
Di-n-octylphthalate	ND(16.9)	1.0	ND(17.1)	1.1	ND(17.0)	1.0	ND(16.6)	1.0	ND(18.2)	1.1	ND(16.7)	1.0
Methylphthalates	ND(16.9)	1.8	ND(17.1)	1.9	ND(17.0)	1.8	27.8	3.0	21.9	2.4	20.1	2.2
N-Nitroso di-n-propylamine	472.0	79.8	167.8	28.4	149.3	25.2	82.8	14.0	62.0	10.5	50.2	8.5
N-Nitrosodiphenylamine	ND(16.9)	3.1	ND(17.1)	3.2	ND(17.0)	3.1	ND(16.6)	3.1	ND(18.2)	3.4	ND(16.7)	3.1
Naphthalene	337.2	63.2	119.9	22.5	135.7	25.5	82.8	15.5	54.7	10.3	46.8	8.8
Phenanthrene	ND(16.9)	2.3	ND(17.1)	2.3	ND(17.0)	2.3	ND(16.6)	2.2	ND(18.2)	2.5	ND(16.7)	2.3
Phenol	269.7	68.9	78.8	20.1	40.7	10.4	ND(16.6)	4.2	ND(18.2)	4.7	ND(16.7)	4.3

ND - Not detected; parenthetical value is PQL.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations													
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	
	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv	ng/m ³	ppiv
Sample Date: 10/07/93														
1,2-Dichlorobenzene	120.8	19.8	ND(16.8)	2.7	19.9	3.3	ND(16.5)	2.7	ND(16.5)	2.7	ND(16.5)	2.7	ND(15.9)	2.6
1,3-Dichlorobenzene	ND(17.3)	2.8	ND(16.8)	2.7	ND(16.3)	2.7	ND(16.5)	2.7	ND(16.5)	2.7	ND(16.5)	2.7	ND(15.9)	2.6
1,4-Dichlorobenzene	19.3	3.2	18.5	3.0	ND(16.3)	2.7	ND(16.5)	2.7	ND(16.5)	2.7	ND(16.5)	2.7	ND(15.9)	2.6
Bis(2-ethylhexyl)phthalate	32.8	2.0	37.0	2.3	ND(16.3)	1.0	66.0	4.1	ND(16.3)	1.0	16.9	1.0	19.1	1.2
Di-n-butylphthalate	103.5	8.9	18.8	1.6	91.4	7.9	135.5	11.7	102.3	8.8	78.3	6.8	86.1	1.0
Di-n-octylphthalate	ND(17.3)	1.1	ND(16.8)	1.0	ND(16.3)	1.0	ND(16.5)	1.0	ND(16.5)	1.0	ND(15.9)	1.0	11.2	7.4
Diethylphthalate	28.6	3.1	ND(16.8)	1.8	ND(16.3)	1.8	ND(16.5)	1.8	ND(16.5)	1.8	18.9	2.0	ND(15.9)	1.7
Methylnaphthalenes	379.6	64.2	77.3	13.1	62.0	10.5	46.3	7.8	49.5	8.4	39.2	6.6	22.3	3.8
N-Nitroso di-n-propylamine	ND(17.3)	3.2	ND(16.8)	3.1	ND(16.3)	3.0	ND(16.5)	3.1	ND(16.5)	3.0	ND(16.3)	3.0	ND(15.9)	2.9
N-Nitrosodiphenylamine	ND(17.3)	2.1	ND(16.8)	2.0	ND(16.3)	2.0	ND(16.5)	2.0	ND(16.5)	2.0	ND(16.3)	2.0	ND(15.9)	1.9
Naphthalene	279.5	52.4	60.5	11.3	58.7	11.0	56.2	10.5	59.4	11.1	39.2	7.3	22.3	4.2
Phenanthrene	ND(17.3)	2.3	ND(16.8)	2.3	ND(16.3)	2.2	ND(16.5)	2.2	ND(16.5)	2.2	ND(16.3)	2.2	ND(15.9)	2.2
Phenol	793.7	202.7	90.7	23.2	62.0	15.8	ND(16.5)	4.2	21.1	5.4	17.0	4.3	31.9	8.1
Sample Date: 10/08/93														
1,2-Dichlorobenzene	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.4)	2.7	ND(16.6)	2.7	33.2	5.4	16.4	2.7
1,3-Dichlorobenzene	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.4)	2.7	ND(16.6)	2.7	ND(16.6)	2.7	ND(16.4)	2.7
1,4-Dichlorobenzene	ND(16.9)	2.8	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.4)	2.7	ND(16.6)	2.7	ND(16.6)	2.7	ND(15.7)	2.6
Bis(2-ethylhexyl)phthalate	17.9	1.1	ND(16.3)	1.0	17.8	1.1	ND(16.4)	1.0	36.6	2.3	31.9	2.0	23.0	1.4
Di-n-butylphthalate	124.9	10.8	88.2	7.6	75.6	6.5	68.9	6.0	169.6	14.6	126.3	10.9	124.9	1.8
Di-n-octylphthalate	ND(16.9)	1.0	ND(16.3)	1.0	ND(16.4)	1.0	ND(16.4)	1.0	ND(16.6)	1.0	ND(16.6)	1.0	ND(16.4)	1.8
Diethylphthalate	ND(16.9)	1.8	ND(16.3)	1.8	ND(16.4)	1.8	ND(16.4)	1.8	ND(16.6)	1.8	ND(16.6)	1.8	ND(16.4)	1.8
Methylnaphthalenes	101.3	17.1	35.9	6.1	85.5	14.4	30.5	5.2	43.2	7.3	136.3	23.0	59.2	10.0
N-Nitroso di-n-propylamine	ND(16.9)	3.1	ND(16.3)	3.0	ND(16.4)	3.0	ND(16.4)	3.0	ND(16.6)	3.1	ND(16.6)	3.1	ND(16.4)	3.0
N-Nitrosodiphenylamine	ND(16.9)	2.0	ND(16.3)	2.0	ND(16.4)	2.0	ND(16.4)	2.0	ND(16.6)	2.0	ND(16.6)	2.0	ND(16.4)	2.0
Naphthalene	81.0	15.2	26.1	4.9	82.2	15.4	32.8	6.2	46.5	8.7	103.1	19.3	49.3	9.3
Phenanthrene	ND(16.9)	2.3	ND(16.3)	2.2	ND(16.4)	2.2	ND(16.4)	2.2	ND(16.6)	2.2	ND(16.6)	2.2	ND(16.4)	2.2
Phenol	108.0	27.6	ND(16.3)	4.2	59.2	15.1	21.7	5.5	33.2	8.5	186.2	47.6	822.0	210.0

ND - Not detected, parenthetical value is POL.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations											
	A1		A2		A3		A4		A5		A6	
	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv
Sample Date: 10/12/93												
1,2-Dichlorobenzene	26.8	4.4	23.8	3.9	ND(16.8)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.9)	2.8
1,3-Dichlorobenzene	ND(16.7)	2.7	ND(17.0)	2.8	ND(16.8)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.9)	2.8
1,4-Dichlorobenzene	ND(16.7)	2.7	ND(17.0)	2.8	ND(16.8)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.9)	2.8
Bis(2-ethylhexyl)phthalate	ND(16.7)	1.0	ND(17.0)	1.0	ND(16.8)	1.0	ND(16.7)	1.0	ND(16.7)	1.0	ND(16.9)	1.0
Di-n-butylphthalate	56.9	4.9	68.0	5.9	63.7	5.5	56.7	4.9	63.5	5.5	61.0	4.1
Di-n-octylphthalate	ND(16.7)	1.0	ND(17.0)	1.0	ND(16.8)	1.0	ND(16.7)	1.0	ND(16.7)	1.0	ND(16.9)	1.0
Diethylphthalate	ND(16.7)	1.8	ND(17.0)	1.8	ND(16.8)	1.8	ND(16.7)	1.8	ND(16.7)	1.8	ND(16.9)	1.8
Methylnaphthalenes	140.6	23.8	142.7	24.1	60.4	10.2	28.0	4.7	23.7	4.0	32.5	5.5
N-Nitroso di-n-propylamine	ND(16.7)	3.1	ND(17.0)	3.1	ND(16.8)	3.1	ND(16.7)	3.1	ND(16.7)	3.1	ND(16.9)	3.1
N-Nitrosodiphenylamine	ND(16.7)	2.0	ND(17.0)	2.1	ND(16.8)	2.0	ND(16.7)	2.0	ND(16.7)	2.0	ND(16.9)	2.1
Naphthalene	70.3	13.2	84.9	15.9	43.6	8.2	28.0	5.3	26.8	5.0	47.4	8.9
Phenanthrene	ND(16.7)	2.3	ND(17.0)	2.3	ND(16.8)	2.3	ND(16.7)	2.2	ND(16.7)	2.3	ND(16.9)	2.3
Phenol	1406.5	359.3	1461.1	373.2	100.6	25.7	28.0	7.2	19.1	4.9	19.6	5.0
Sample Date: 10/13/93												
1,2-Dichlorobenzene	ND(16.0)	2.6	ND(16.5)	2.7	ND(16.0)	2.6	ND(17.5)	2.9	ND(15.9)	2.6	ND(16.2)	2.7
1,3-Dichlorobenzene	ND(16.0)	2.6	ND(16.5)	2.7	ND(16.0)	2.6	ND(17.5)	2.9	ND(15.9)	2.6	ND(16.2)	2.7
1,4-Dichlorobenzene	ND(16.0)	2.6	ND(16.5)	2.7	ND(16.0)	2.6	ND(17.5)	2.9	ND(15.9)	2.6	ND(16.2)	2.7
Bis(2-ethylhexyl)phthalate	21.2	1.3	105.5	6.5	224.1	13.8	29.4	1.8	47.6	2.9	21.1	1.3
Di-n-butylphthalate	96.3	8.3	105.5	9.1	89.7	7.7	146.9	12.7	69.8	6.0	94.0	8.1
Di-n-octylphthalate	ND(16.0)	1.0	49.5	3.0	ND(16.0)	1.0	ND(17.5)	1.1	ND(15.9)	1.0	ND(16.2)	1.0
Diethylphthalate	24.7	2.7	ND(16.5)	1.8	22.4	2.4	ND(17.5)	1.9	ND(15.9)	1.7	ND(16.2)	1.8
Methylnaphthalenes	375.5	63.5	118.7	20.1	51.2	8.7	73.4	12.4	41.3	7.0	64.8	11.0
N-Nitroso di-n-propylamine	ND(16.0)	3.0	ND(16.5)	3.0	ND(16.0)	3.0	ND(17.5)	3.2	ND(15.9)	2.9	ND(16.2)	3.0
N-Nitrosodiphenylamine	ND(16.0)	1.9	ND(16.5)	2.0	ND(16.0)	1.9	ND(17.5)	2.1	ND(15.9)	1.9	ND(16.2)	2.0
Naphthalene	205.4	38.5	99.0	18.6	35.2	6.6	59.4	11.1	34.9	6.5	61.6	11.6
Phenanthrene	ND(16.0)	2.2	ND(16.5)	2.2	ND(16.0)	2.2	ND(17.5)	2.4	ND(15.9)	2.1	ND(16.2)	2.2
Phenol	930.8	237.8	108.8	27.8	28.8	7.4	31.5	8.0	24.1	6.2	35.7	9.1

ND - Not detected, parenthetical value is PQL.

+ - No data indicates sample not collected or invalid.

Table 4.52 (continued)
SYOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

	ANALYTE	Station Locations																									
		A1		A2		A3		A4		A5		A6		A7		A8		A9		A10		A11		A12		A13	
		ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv
Sample Date: 10/15/93	1,2-Dichlorobenzene	ND(16.5)	2.7	ND(16.8)	2.7	ND(16.5)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.3)	2.7	ND(16.9)	2.8	ND(17.2)	2.8
	1,3-Dichlorobenzene	ND(16.5)	2.7	ND(16.8)	2.7	ND(16.5)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.3)	2.7	ND(16.9)	2.8	ND(17.2)	2.8
	1,4-Dichlorobenzene	ND(16.5)	2.7	ND(16.8)	2.7	ND(16.5)	2.7	ND(16.7)	2.7	ND(16.7)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.8)	2.7	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.3)	2.7	ND(16.9)	2.8	ND(17.2)	2.8
	Bis(2-ethylhexyl)phthalate	17.4	1.1	63.8	3.9	39.5	2.4	70.2	4.3	22.7	1.4	122.9	7.6	63.6	3.9	127.3	7.8	109.8	6.8	52.8	3.2	16.9	1.0	ND(16.9)	1.0	ND(17.2)	1.1
	Di-n-butylphthalate	138.2	11.9	67.2	5.8	65.9	5.7	66.9	5.7	183.4	15.8	83.0	7.2	77.0	6.7	ND(16.8)	1.4	93.2	8.0	89.1	7.7	104.1	9.0	178.7	15.4	96.2	8.3
	Di-n-octylphthalate	ND(16.5)	1.0	25.5	1.6	ND(16.5)	1.0	27.8	1.7	ND(16.7)	1.0	53.1	3.3	24.1	1.5	ND(16.8)	1.0	46.6	2.9	ND(16.5)	1.0	ND(16.3)	1.0	ND(16.9)	1.0	ND(17.2)	1.1
	Diethylphthalate	22.4	2.4	ND(16.8)	1.8	ND(16.5)	1.8	17.7	1.9	ND(16.7)	1.8	ND(16.6)	1.8	ND(16.7)	1.8	ND(16.8)	1.8	ND(16.6)	1.8	ND(16.5)	1.8	ND(16.3)	1.8	ND(16.9)	1.8	ND(17.2)	1.9
	Methylnaphthalenes	141.5	23.9	57.1	9.7	36.2	6.1	20.1	3.4	63.3	10.7	22.3	3.8	18.1	3.1	23.1	3.9	31.3	5.3	20.8	3.5	130.1	22.0	151.7	25.6	24.0	4.1
	N-Nitroso di-n-propylamine	ND(16.5)	3.0	ND(16.8)	3.1	ND(16.5)	3.0	ND(16.7)	3.1	ND(16.7)	3.1	ND(16.6)	3.1	ND(16.7)	3.1	ND(16.8)	3.1	ND(16.6)	3.1	ND(16.5)	3.0	ND(16.3)	3.0	ND(16.9)	3.1	ND(17.2)	3.2
	N-Nitrosodiphenylamine	ND(16.5)	2.0	ND(16.8)	2.0	ND(16.5)	2.0	ND(16.7)	2.0	ND(16.7)	2.0	ND(16.6)	2.0	ND(16.7)	2.0	ND(16.8)	2.0	ND(16.6)	2.0	ND(16.5)	2.0	ND(16.3)	2.0	ND(16.9)	2.0	ND(17.2)	2.1
	Naphthalene	121.8	22.8	40.3	7.6	24.7	4.6	21.7	4.1	43.3	8.1	21.9	4.1	20.1	3.8	23.5	4.4	30.0	5.6	19.8	3.7	65.1	12.2	64.0	12.0	ND(17.2)	3.2
	Phenanthrene	ND(16.5)	2.2	ND(16.8)	2.3	ND(16.5)	2.2	ND(16.7)	2.3	ND(16.7)	2.2	ND(16.6)	2.2	ND(16.7)	2.3	ND(16.8)	2.3	ND(16.6)	2.2	ND(16.5)	2.2	ND(16.3)	2.2	ND(16.9)	2.3	ND(17.2)	2.3
	Phenol	302.8	77.4	40.3	10.3	27.3	7.0	ND(16.7)	4.3	21.7	5.5	17.6	4.5	21.1	5.4	22.1	5.6	ND(16.6)	4.3	ND(16.5)	4.2	172.4	44.0	ND(16.9)	4.3	24.0	6.1
Sample Date: 10/18/93	1,2-Dichlorobenzene	ND(16.8)	2.7	ND(17.3)	2.8	ND(17.0)	2.8	ND(16.8)	2.8	ND(16.7)	2.7	ND(17.2)	2.8	ND(17.3)	2.8	ND(17.9)	2.9	ND(18.0)	2.9	ND(17.6)	2.9	ND(16.6)	2.7	ND(15.8)	2.6	ND(16.5)	2.7
	1,3-Dichlorobenzene	ND(16.8)	2.7	ND(17.3)	2.8	ND(17.0)	2.8	ND(16.8)	2.8	ND(16.7)	2.7	ND(17.2)	2.8	ND(17.3)	2.8	ND(17.9)	2.9	ND(18.0)	2.9	ND(17.6)	2.9	ND(16.6)	2.7	ND(15.8)	2.6	ND(16.5)	2.7
	1,4-Dichlorobenzene	ND(16.8)	2.7	ND(17.3)	2.8	ND(17.0)	2.8	ND(16.8)	2.8	ND(16.7)	2.7	ND(17.2)	2.8	ND(17.3)	2.8	ND(17.9)	2.9	ND(18.0)	2.9	ND(17.6)	2.9	ND(16.6)	2.7	ND(15.8)	2.6	ND(16.5)	2.7
	Bis(2-ethylhexyl)phthalate	20.2	1.2	31.1	1.9	27.2	1.7	ND(16.8)	1.0	66.9	4.1	ND(17.2)	1.1	17.3	1.1	28.7	1.8	129.3	8.0	ND(17.6)	1.1	23.3	1.4	ND(15.8)	1.0	36.3	2.2
	Di-n-butylphthalate	195.0	16.8	314.2	27.1	241.6	20.9	124.6	10.8	90.4	7.8	140.9	12.2	155.8	13.5	308.1	26.6	255.0	22.0	109.0	9.4	226.2	19.5	158.0	13.6	356.5	30.8
	Di-n-octylphthalate	ND(16.8)	1.0	ND(17.3)	1.1	ND(17.0)	1.0	ND(16.8)	1.0	26.8	1.6	ND(17.2)	1.1	ND(17.3)	1.1	ND(17.9)	1.1	39.5	2.4	ND(17.6)	1.1	ND(16.6)	1.0	ND(15.8)	1.0	ND(16.5)	1.0
	Diethylphthalate	ND(16.8)	1.8	ND(17.3)	1.9	ND(17.0)	1.8	ND(16.8)	1.8	ND(16.7)	1.8	ND(17.2)	1.9	ND(17.3)	1.9	ND(17.9)	1.9	ND(18.0)	1.9	ND(17.6)	1.9	53.2	5.8	ND(15.8)	1.7	ND(16.5)	1.8
	Methylnaphthalenes	47.1	8.0	62.2	10.5	57.9	9.8	60.6	10.2	56.9	9.6	55.0	9.3	86.5	14.6	68.1	11.5	125.7	21.3	63.3	10.7	56.5	9.6	47.4	8.0	46.2	7.8
	N-Nitroso di-n-propylamine	ND(16.8)	3.1	ND(17.3)	3.2	ND(17.0)	3.1	ND(16.8)	3.1	ND(16.7)	3.1	ND(17.2)	3.2	ND(17.3)	3.2	ND(17.9)	3.3	ND(18.0)	3.3	ND(17.6)	3.2	ND(16.6)	3.1	ND(15.8)	2.9	ND(16.5)	3.0
	N-Nitrosodiphenylamine	ND(16.8)	2.0	ND(17.3)	2.1	ND(17.0)	2.1	ND(16.8)	2.0	ND(16.7)	2.0	ND(17.2)	2.1	ND(17.3)	2.1	ND(17.9)	2.2	ND(18.0)	2.2	ND(17.6)	2.1	ND(16.6)	2.0	ND(15.8)	1.9	ND(16.5)	2.0
	Naphthalene	57.1	10.7	72.5	13.6	68.1	12.8	77.4	14.5	60.2	11.3	68.7	12.9	76.2	14.3	46.6	8.7	97.0	18.2	70.3	13.2	73.2	13.7	56.9	10.7	49.5	9.3
	Phenanthrene	ND(16.8)	2.3	ND(17.3)	2.3	ND(17.0)	2.3	ND(16.8)	2.3	ND(16.7)	2.3	ND(17.2)	2.3	ND(17.3)	2.3	ND(17.9)	2.4	ND(18.0)	2.4	ND(17.6)	2.4	ND(16.6)	2.2	ND(15.8)	2.1	ND(16.5)	2.2
	Phenol	ND(16.8)	4.3	ND(17.3)	4.4	ND(17.0)	4.3	ND(16.8)	4.3	ND(16.7)	4.3	17.2	4.4	69.2	17.7	136.1	34.8	211.9	54.1	21.1	5.4	ND(16.6)	4.2	ND(15.8)	4.0	ND(16.5)	4.2

ND - Not detected, parenthetical value is PQL.

490RB/721411ng_1015.mk3

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Location												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³	ng/m ³
	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv	pptv
Sample Date: 10/20/93													
1,2-Dichlorobenzene	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
1,3-Dichlorobenzene	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
1,4-Dichlorobenzene	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Bis(2-ethylhexyl)phthalate	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	15.8	58.2	ND(16.5)
Di-n-butylphthalate	119.3	158.0	13.6	96.6	132.7	145.6	104.8	149.7	137.5	123.8	176.9	255.3	ND(16.5)
Di-n-octylphthalate	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Diethylphthalate	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Methylphthalates	29.0	29.6	3.0	38.6	64.7	77.6	101.5	100.9	75.3	65.2	44.2	42.0	ND(16.5)
N-Nitroso di-n-propylamine	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
N-Nitrosodiphenylamine	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Naphthalene	38.7	36.2	6.8	54.8	84.2	74.4	72.0	84.6	101.5	84.7	66.4	58.2	ND(16.5)
Phenanthrene	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Phenol	ND(16.1)	ND(16.5)	ND(16.1)	ND(16.2)	ND(16.2)	ND(16.2)	ND(16.4)	ND(16.3)	ND(16.4)	ND(16.3)	ND(15.8)	ND(16.2)	ND(16.5)
Sample Date: 10/25/93													
1,2-Dichlorobenzene	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
1,3-Dichlorobenzene	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
1,4-Dichlorobenzene	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Bis(2-ethylhexyl)phthalate	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Di-n-butylphthalate	143.8	126.7	10.9	153.0	245.8	129.8	119.2	132.5	117.9	124.1	115.3	139.4	ND(16.6)
Di-n-octylphthalate	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Diethylphthalate	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Methylphthalates	92.6	42.2	7.1	76.5	35.1	69.7	61.2	28.4	39.3	38.2	64.0	31.1	ND(16.6)
N-Nitroso di-n-propylamine	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
N-Nitrosodiphenylamine	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Naphthalene	57.5	27.6	73.3	44.7	35.1	63.3	48.3	18.1	32.8	29.6	38.4	ND(16.2)	ND(16.6)
Phenanthrene	ND(16.0)	ND(16.2)	ND(15.9)	ND(16.0)	ND(16.0)	ND(15.8)	ND(16.1)	ND(16.2)	ND(16.4)	ND(15.9)	ND(16.0)	ND(16.2)	ND(16.6)
Phenol	127.8	28.6	28.7	7.3	ND(16.0)	34.8	164.3	216.5	26.5	92.3	70.4	28.2	ND(16.6)

ND - Not detected, parenthetical value is PQL.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

Sample Date: 10/27/93	ANAL YTE	Station Locations																										
		A1		A2		A3		A4		A5		A6		A7		A8		A9		A10		A11		A12		A13		
		ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	
1,2-Dichlorobenzene	ND(15.9)	2.6	38.9	6.4	ND(15.8)	2.6	ND(16.0)	2.6	ND(15.6)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(16.2)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(15.9)	2.6	82.2	13.4	ND(16.0)	2.6	ND(16.2)	2.7
1,3-Dichlorobenzene	ND(15.9)	2.6	ND(16.2)	2.7	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(15.9)	2.6	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.2)	2.7
1,4-Dichlorobenzene	ND(15.9)	2.6	ND(16.2)	2.7	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(16.2)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(15.9)	2.6	22.1	3.6	ND(16.0)	2.6	ND(16.2)	2.7
Bis(2-ethylhexyl)phthalate	ND(15.9)	1.0	ND(16.2)	1.0	ND(15.8)	1.0	ND(16.0)	1.0	15.6	1.0	ND(16.2)	1.0	ND(16.0)	1.0	ND(16.2)	1.0	ND(16.0)	1.0	ND(16.0)	1.0	ND(15.9)	1.0	91.7	5.6	19.2	5.6	19.2	2.7
Di-n-butylphthalate	200.2	17.3	126.5	10.9	164.4	14.2	176.5	15.2	197.0	17.0	ND(16.2)	13.3	142.1	12.3	166.9	14.4	143.2	12.4	211.9	18.3	175.8	15.2	29.2	311.7	26.9	311.7	1.8	
Diethylphthalate	ND(15.9)	1.0	ND(16.2)	1.0	ND(15.8)	1.0	ND(16.0)	1.0	ND(15.6)	1.0	ND(16.2)	1.0	ND(16.0)	1.0	ND(16.2)	1.0	ND(15.9)	1.0	ND(15.8)	1.0	ND(16.0)	1.0	ND(15.8)	1.0	ND(16.0)	1.0	ND(16.2)	1.8
Methylisophthalates	ND(15.9)	1.7	ND(16.2)	1.8	ND(15.8)	1.7	ND(16.0)	1.7	ND(15.6)	1.7	ND(16.2)	1.7	ND(16.0)	1.7	ND(16.2)	1.7	ND(15.9)	1.7	ND(15.8)	1.7	ND(15.8)	1.7	271.9	46.0	25.6	4.3	39.0	6.6
N-Nitroso di-n-propylamine	ND(15.9)	2.9	ND(16.2)	3.0	ND(15.8)	2.9	ND(16.0)	3.0	ND(15.6)	2.9	ND(16.2)	3.0	ND(16.0)	3.0	ND(16.2)	3.0	ND(15.9)	2.9	ND(15.8)	2.9	ND(16.0)	3.0	ND(15.8)	2.9	ND(16.0)	3.0	ND(16.2)	3.0
N-Nitrosodiphenylamine	ND(15.9)	1.9	ND(16.2)	2.0	ND(15.8)	1.9	ND(16.0)	1.9	ND(15.6)	1.9	ND(16.2)	2.0	ND(16.0)	1.9	ND(16.2)	2.0	ND(15.9)	1.9	ND(15.8)	1.9	ND(16.0)	1.9	ND(15.8)	1.9	ND(16.0)	1.9	ND(16.2)	3.0
Naphthalene	508.4	95.4	94.0	17.6	69.5	13.0	61.0	11.4	46.9	8.8	64.6	12.1	60.8	11.4	45.2	8.5	41.7	10.7	205.5	38.5	25.6	4.8	42.2	2.9	19.5	7.4	19.5	2.9
Phenanthrene	ND(15.9)	2.1	ND(16.2)	2.2	ND(15.8)	2.1	ND(16.0)	2.2	ND(15.6)	2.1	ND(16.2)	2.2	ND(16.0)	2.2	ND(16.2)	2.2	ND(15.9)	2.1	ND(15.8)	2.1	ND(15.8)	2.1	ND(15.8)	2.1	ND(16.0)	2.2	ND(16.2)	2.2
Phenol	2128.9	543.8	356.7	91.1	101.1	25.8	57.8	14.8	53.2	13.6	67.8	17.3	89.5	22.9	71.1	18.2	22.5	28.6	7.3	1802.3	460.4	54.4	13.9	42.2	10.8	42.2	10.8	
Sample Date: 10/29/93																												
1,2-Dichlorobenzene	ND(15.7)	2.6	ND(16.1)	2.6	ND(16.0)	2.6	ND(15.4)	2.5	ND(14.6)	2.4	ND(15.6)	2.6	ND(15.6)	2.6	ND(15.9)	2.6	ND(15.5)	2.5	ND(15.6)	2.5	ND(15.6)	2.5	ND(15.8)	2.6	ND(15.7)	2.6	ND(16.3)	2.7
1,3-Dichlorobenzene	ND(15.7)	2.6	ND(16.1)	2.6	ND(16.0)	2.6	ND(15.4)	2.5	ND(14.6)	2.4	ND(15.6)	2.6	ND(15.6)	2.6	ND(15.9)	2.6	ND(15.5)	2.5	ND(15.6)	2.5	ND(15.6)	2.5	ND(15.8)	2.6	ND(15.7)	2.6	ND(16.3)	2.7
1,4-Dichlorobenzene	ND(15.7)	2.6	ND(16.1)	2.6	ND(16.0)	2.6	ND(15.4)	2.5	ND(14.6)	2.4	ND(15.6)	2.6	ND(15.6)	2.6	ND(15.9)	2.6	ND(15.5)	2.5	ND(15.6)	2.5	ND(15.6)	2.5	ND(15.8)	2.6	ND(15.7)	2.6	ND(16.3)	2.7
Bis(2-ethylhexyl)phthalate	15.7	1.0	29.1	1.8	22.4	1.4	ND(15.4)	0.9	26.2	1.6	28.1	1.7	34.4	2.1	28.5	1.8	ND(15.5)	1.0	43.6	2.2	43.6	2.2	22.2	1.4	25.1	2.6	ND(16.3)	2.7
Di-n-butylphthalate	194.4	16.8	ND(16.1)	1.4	258.9	22.4	185.0	16.0	291.6	25.2	312.7	27.0	406.6	35.1	152.2	13.1	145.5	12.6	436.4	37.7	193.3	16.7	273.2	23.6	282.8	24.4	282.8	1.8
Di-n-octylphthalate	ND(15.7)	1.0	ND(16.1)	1.0	ND(16.0)	1.0	ND(15.4)	0.9	ND(14.6)	0.9	ND(15.6)	1.0	ND(15.6)	1.0	ND(15.9)	1.0	ND(15.5)	1.0	ND(15.6)	1.0	ND(15.6)	1.0	ND(15.8)	1.0	ND(15.7)	1.0	ND(16.3)	1.0
Diethylphthalate	ND(15.7)	1.7	ND(16.1)	1.7	ND(16.0)	1.7	ND(15.4)	1.7	ND(14.6)	1.6	ND(15.6)	1.7	ND(15.6)	1.7	ND(15.9)	1.7	ND(15.5)	1.7	ND(15.6)	1.7	ND(15.6)	1.7	ND(15.8)	1.7	ND(15.7)	1.7	ND(16.3)	1.8
Methylisophthalates	31.3	5.3	38.8	6.6	35.2	5.9	46.2	7.8	52.5	8.9	96.9	16.4	143.9	24.3	202.9	34.3	21.7	3.7	28.1	4.7	34.9	5.9	31.4	5.3	42.3	7.1	42.3	1.8
N-Nitroso di-n-propylamine	ND(15.7)	2.9	32.3	6.0	22.4	4.1	ND(15.4)	2.8	ND(14.6)	2.7	ND(15.6)	2.9	ND(15.6)	2.9	ND(15.9)	2.9	ND(15.5)	2.9	ND(15.6)	2.9	ND(15.6)	2.9	ND(15.8)	2.9	ND(15.7)	2.9	ND(16.3)	3.0
N-Nitrosodiphenylamine	ND(15.7)	1.9	ND(16.1)	2.0	ND(16.0)	1.9	ND(15.4)	1.9	ND(14.6)	1.9	ND(15.6)	2.0	ND(15.6)	2.0	ND(15.9)	1.9	ND(15.5)	1.9	ND(15.6)	1.9	ND(15.6)	1.9	ND(15.8)	1.9	ND(15.7)	1.9	ND(16.3)	3.0
Naphthalene	40.8	54.9	54.9	10.3	51.1	9.6	67.8	12.7	72.9	13.7	84.4	15.8	109.5	20.5	155.3	29.1	31.0	5.8	37.4	7.0	50.7	9.5	47.1	12.2	19.5	2.4	19.5	2.4
Phenanthrene	ND(15.7)	2.1	ND(16.1)	2.2	ND(16.0)	2.2	ND(15.4)	2.1	ND(14.6)	2.0	ND(15.6)	2.1	ND(15.6)	2.1	ND(15.9)	2.1	ND(15.5)	2.1	ND(15.6)	2.1	ND(15.6)	2.1	ND(15.8)	2.1	ND(15.7)	2.1	ND(16.3)	2.2
Phenol	31.3	8.0	25.8	6.6	22.4	5.7	24.7	6.3	32.1	8.2	131.3	33.5	844.4	215.7	1204.7	307.7	21.7	5.5	18.7	4.8	28.5	7.3	28.3	7.2	32.5	8.3	32.5	8.3
ND - Not detected, parentchemical value is POL.																												
450R073141.DP	10/27/93																											

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	Station Locations																											
	A1		A2		A3		A4		A5		A6		A7		A8		A9		A10		A11		A12+		A13			
	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv	ng/m3	pptv
Sample Date: 11/01/93																												
1,2-Dichlorobenzene	39.3	6.4	ND(16.9)	2.8	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.4)	2.7	ND(16.8)	2.7	ND(16.8)	2.8	ND(16.6)	2.7	23.0	3.8			20.5	3.4		
1,3-Dichlorobenzene	ND(16.4)	2.7	ND(16.9)	2.8	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.4)	2.7	ND(16.8)	2.7	ND(16.8)	2.8	ND(16.6)	2.7	ND(16.5)	2.7			ND(17.1)	2.8		
1,4-Dichlorobenzene	ND(16.4)	2.7	ND(16.9)	2.8	ND(16.6)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(16.7)	2.7	ND(16.4)	2.7	ND(16.8)	2.7	ND(16.8)	2.8	ND(16.6)	2.7	ND(16.5)	2.7			ND(17.1)	2.8		
Bis(2-ethylhexyl)phthalate	26.2	1.6	23.7	1.5	29.9	1.8	29.6	1.8	19.9	1.2	23.4	1.4	36.2	1.4	23.5	1.4	23.5	1.4	33.1	2.0	29.6	1.8			30.7	1.9		
Di-n-butylphthalate	245.9	21.2	165.7	14.3	325.7	28.1	273.3	23.6	172.3	14.9	237.2	20.5	ND(16.4)	1.4	254.7	22.2	242.2	20.9	255.0	22.0	151.4	13.1			259.6	22.4		
Di-n-octylphthalate	ND(16.4)	1.0	ND(16.9)	1.0	ND(16.6)	1.0	ND(16.5)	1.0	ND(16.6)	1.0	ND(16.7)	1.0	ND(16.4)	1.0	ND(16.8)	1.0	ND(16.8)	1.0	ND(16.6)	1.0	ND(16.5)	1.0			ND(17.1)	1.1		
Diethylphthalate	ND(16.4)	1.8	27.1	2.9	ND(16.6)	1.8	19.8	2.1	19.9	2.2	23.4	2.5	29.6	3.2	23.5	2.5	23.5	2.5	ND(16.6)	1.8	ND(16.5)	1.8			ND(17.1)	1.8		
Methylphthalates	291.8	49.3	101.5	17.2	49.8	8.4	52.7	8.9	36.4	6.2	40.1	6.8	23.0	3.9	30.2	5.1	37.0	6.3	36.4	6.2	227.2	38.4			184.4	31.2		
N-Nitroso di-n-propylamine	ND(16.4)	3.0	ND(16.9)	3.1	ND(16.6)	3.1	ND(16.5)	3.0	ND(16.6)	3.1	ND(16.7)	3.1	ND(16.4)	3.0	ND(16.8)	3.1	ND(16.8)	3.1	ND(16.6)	3.1	ND(16.5)	3.0			ND(17.1)	3.2		
N-Nitrosodiphenylamine	16.4	2.0	ND(16.9)	2.1	ND(16.6)	2.0	ND(16.5)	2.0	ND(16.6)	2.0	ND(16.7)	2.0	ND(16.7)	2.0	ND(16.8)	2.4	ND(16.8)	2.0	ND(16.6)	2.0	ND(16.5)	2.0			17.1	2.1		
Naphthalene	200.0	37.5	84.6	15.9	53.2	10.0	85.6	16.1	56.3	10.6	63.5	11.9	29.6	5.5	43.6	8.2	60.6	11.4	49.7	9.3	171.2	32.1			109.3	20.5		
Phenanthrene	ND(16.4)	2.2	ND(16.9)	2.3	ND(16.6)	2.2	ND(16.5)	2.2	ND(16.6)	2.2	ND(16.7)	2.3	ND(16.4)	2.2	ND(16.8)	2.3	ND(16.8)	2.3	ND(16.6)	2.2	ND(16.5)	2.2			ND(17.1)	2.3		
Phenol	1409.9	360.1	189.4	48.4	139.6	35.7	92.2	23.5	69.6	17.8	100.2	25.6	111.8	28.6	103.9	26.5	107.6	27.5	96.0	24.5	1119.3	285.9			ND(17.1)	4.4		
Sample Date: 11/02/93																												
1,2-Dichlorobenzene	ND(16.4)	2.7	40.2	6.6	81.9	13.4	59.0	9.6	19.6	3.2	65.8	10.8	52.6	8.6	72.8	11.9	174.2	28.5	221.0	36.1	129.8	21.2			71.2	11.6		
1,3-Dichlorobenzene	ND(16.4)	2.7	ND(16.7)	2.7	ND(16.4)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.5)	2.7	ND(16.6)	2.7	ND(16.8)	2.7	ND(16.2)	2.7	ND(16.2)	2.7			ND(16.2)	2.7		
1,4-Dichlorobenzene	ND(16.4)	2.7	100.4	16.4	39.3	6.4	26.2	4.3	ND(16.3)	2.7	29.5	4.8	19.7	3.2	16.6	2.7	33.5	5.5	65.0	10.6	45.4	7.4			19.4	3.2		
Bis(2-ethylhexyl)phthalate	23.0	1.4	43.5	2.7	16.4	1.0	19.7	1.2	19.6	1.2	16.4	1.0	23.0	1.4	16.6	1.0	33.5	2.1	19.5	1.2	26.0	1.6			16.2	2.7		
Di-n-butylphthalate	289.4	25.0	602.7	52.1	180.2	15.6	199.9	17.3	215.7	18.6	164.5	14.2	246.8	21.3	208.6	18.0	335.1	28.9	165.7	14.3	233.7	20.2			194.2	23.5		
Di-n-octylphthalate	ND(16.4)	1.0	ND(16.7)	1.0	ND(16.4)	1.0	ND(16.4)	1.0	ND(16.3)	1.0	ND(16.4)	1.0	ND(16.5)	1.0	ND(16.6)	1.0	ND(16.8)	1.0	ND(16.2)	1.0	ND(16.2)	1.0			ND(16.2)	1.0		
Diethylphthalate	ND(16.4)	1.8	ND(16.7)	1.8	ND(16.4)	1.8	ND(16.4)	1.8	ND(16.3)	1.8	ND(16.4)	1.8	ND(16.5)	1.8	ND(16.6)	1.8	ND(16.8)	1.8	ND(16.2)	1.8	ND(16.2)	1.8			ND(16.2)	1.8		
Methylphthalates	322.3	54.5	281.3	47.5	301.4	50.9	209.8	35.5	134.0	22.7	230.3	38.9	154.6	26.1	106.0	17.9	268.0	45.3	389.9	65.9	227.2	38.4			116.5	13.6		
N-Nitroso di-n-propylamine	ND(16.4)	3.0	ND(16.7)	3.1	ND(16.4)	3.0	ND(16.4)	3.0	ND(16.3)	3.0	ND(16.4)	3.0	ND(16.5)	3.0	ND(16.6)	3.1	ND(16.8)	3.1	ND(16.2)	3.0	ND(16.2)	3.0			ND(16.2)	3.0		
N-Nitrosodiphenylamine	19.7	2.4	33.5	4.1	ND(16.4)	2.0	ND(16.4)	2.0	ND(16.3)	2.0	ND(16.4)	2.0	ND(16.5)	2.0	ND(16.6)	2.0	20.1	2.4	19.5	2.4	ND(16.2)	2.0			ND(16.2)	2.0		
Naphthalene	276.2	51.8	231.0	43.3	262.1	49.2	255.6	47.9	130.7	24.5	250.0	46.9	154.6	29.0	122.5	23.0	234.5	44.0	259.9	48.8	191.5	35.9			100.4	18.8		
Phenanthrene	ND(16.4)	2.2	ND(16.7)	2.3	ND(16.4)	2.2	ND(16.4)	2.2	ND(16.3)	2.2	ND(16.4)	2.2	ND(16.5)	2.2	ND(16.6)	2.2	ND(16.8)	2.3	ND(16.2)	2.2	ND(16.2)	2.2			ND(16.8)	2.3		
Phenol	559.1	142.8	569.2	145.4	317.7	81.2	124.5	31.8	85.0	21.7	197.4	50.4	177.7	45.4	109.3	27.9	211.1	53.9	877.3	224.1	843.9	215.6			97.1	24.8		

ND - Not detected; parenthetical value is PQL.

450RB72141/np_1001.wk3

ND - Not detected, parenthetical value is PQL.
± - Results not yet received

450RB073141/00_11011.xls

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	A1		A2		A3		A4		A5		A6		Station Locations		A7		A8		A9		A10		A11		A12		A13	
	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv	ng/m ³	pptv
Sample Date: 11/04/93																												
1,2-Dichlorobenzene	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.0)	2.6	ND(16.1)	2.6	22.8	3.7	52.7	8.6	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.3)	2.7	ND(16.8)	2.8
1,3-Dichlorobenzene	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.0)	2.6	ND(16.1)	2.6	ND(16.3)	2.7	ND(16.5)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.3)	2.7	ND(16.8)	2.8
1,4-Dichlorobenzene	ND(16.3)	2.7	ND(16.4)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.0)	2.6	ND(16.1)	2.6	ND(16.3)	2.7	ND(16.5)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.3)	2.7	ND(16.0)	2.6	ND(16.3)	2.7	ND(16.8)	2.8
Bis(2-ethylhexyl)phthalate	ND(16.3)	1.0	ND(16.4)	1.0	ND(16.3)	1.0	ND(16.0)	1.0	ND(16.0)	1.0	ND(16.1)	1.0	19.6	1.2	ND(16.5)	1.0	42.3	2.6	ND(16.3)	2.6	ND(16.3)	2.6	ND(16.0)	2.6	ND(16.3)	2.7	ND(16.8)	2.8
Di-n-butylphthalate	189.5	16.4	151.1	13.1	175.7	15.2	141.1	12.2	176.2	15.2	183.6	15.9	241.5	20.9	177.7	15.3	422.9	2.6	32.5	2.6	32.5	2.6	25.7	2.0	39.2	2.4	33.7	2.1
Di-n-octylphthalate	ND(16.3)	1.0	ND(16.4)	1.0	ND(16.3)	1.0	ND(16.0)	1.0	ND(16.0)	1.0	ND(16.1)	1.0	ND(16.3)	1.0	ND(16.5)	1.0	ND(16.3)	1.0	ND(16.3)	1.0	ND(16.3)	1.0	ND(16.0)	1.0	ND(16.3)	1.0	ND(16.8)	1.0
Diethylphthalate	ND(16.3)	1.8	ND(16.4)	1.8	ND(16.3)	1.8	ND(16.0)	1.7	ND(16.0)	1.7	ND(16.1)	1.7	ND(16.3)	1.8	ND(16.5)	1.8	ND(16.3)	1.8	ND(16.3)	1.8	ND(16.3)	1.8	ND(16.0)	1.7	ND(16.3)	1.8	ND(16.8)	1.8
Methylnaphthalenes	65.4	11.0	98.5	16.7	126.9	21.5	115.4	19.5	102.5	17.3	154.6	26.1	189.3	32.0	207.3	35.1	68.3	11.5	71.5	11.5	74.8	11.5	44.9	7.6	22.9	3.9	20.2	3.4
N-Nitroso di-n-propylamine	ND(16.3)	3.0	ND(16.4)	3.0	ND(16.3)	3.0	ND(16.0)	3.0	ND(16.0)	3.0	ND(16.1)	3.0	ND(16.3)	3.0	ND(16.5)	3.0	ND(16.3)	3.0	ND(16.3)	3.0	ND(16.3)	3.0	ND(16.0)	3.0	ND(16.3)	3.0	ND(16.8)	3.1
N-Nitrosodiphenylamine	ND(16.3)	2.0	ND(16.4)	2.0	ND(16.3)	2.0	ND(16.0)	1.9	ND(16.0)	1.9	ND(16.1)	2.0	ND(16.3)	2.0	ND(16.5)	2.0	ND(16.3)	2.0	ND(16.3)	2.0	ND(16.3)	2.0	ND(16.0)	2.3	29.4	3.6	26.9	3.3
Naphthalene	52.3	9.8	75.6	14.2	87.9	16.5	80.1	15.0	64.1	12.0	83.7	15.7	101.2	19.0	144.8	27.2	78.1	14.6	74.8	14.6	74.8	14.6	38.5	7.2	26.1	4.9	30.3	5.7
Phenanthrene	ND(16.3)	2.2	ND(16.4)	2.2	ND(16.3)	2.2	ND(16.0)	2.2	ND(16.0)	2.2	ND(16.1)	2.2	ND(16.3)	2.2	ND(16.5)	2.2	ND(16.3)	2.2	ND(16.3)	2.2	ND(16.3)	2.2	ND(16.0)	2.2	ND(16.3)	2.2	ND(16.8)	2.3
Phenol	22.9	5.8	59.1	15.1	52.1	13.3	38.5	9.8	38.4	9.8	96.6	24.7	293.8	75.0	460.8	117.7	16.3	4.2	16.3	4.2	16.3	4.2	35.3	9.0	ND(16.3)	4.2	ND(16.8)	4.3
Sample Date: 11/06/93																												
1,2-Dichlorobenzene	61.7	10.1	ND(16.0)	2.6	ND(15.5)	2.5	ND(15.7)	2.6	ND(15.6)	2.5	ND(15.8)	4.6	ND(15.5)	2.5	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(15.8)	2.6	33.8	5.5	63.0	10.3	26.0	4.2
1,3-Dichlorobenzene	ND(15.4)	2.5	ND(16.0)	2.6	ND(15.5)	2.5	ND(15.7)	2.6	ND(15.6)	2.5	ND(15.8)	2.6	ND(15.5)	2.5	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(15.8)	2.6	ND(15.4)	2.5	ND(15.7)	2.6	ND(16.2)	2.7
1,4-Dichlorobenzene	21.6	3.5	28.7	4.7	46.4	7.6	ND(15.7)	2.6	ND(15.6)	2.5	15.8	2.6	ND(15.5)	2.5	ND(15.8)	2.6	ND(16.0)	2.6	ND(16.0)	2.6	ND(15.8)	2.6	ND(15.4)	2.5	ND(15.7)	2.6	ND(16.2)	2.7
Bis(2-ethylhexyl)phthalate	27.8	1.7	16.0	1.0	40.3	2.5	28.3	1.7	ND(15.6)	1.0	18.9	1.2	18.6	1.1	31.6	1.9	25.6	1.6	25.3	1.6	25.3	1.6	ND(15.4)	0.9	22.0	1.4	19.5	1.2
Di-n-butylphthalate	231.5	20.0	188.3	16.3	222.9	19.3	269.9	23.3	162.1	14.0	198.5	17.1	185.6	16.0	211.4	18.3	290.9	25.1	25.1	1.6	25.3	1.6	ND(15.4)	0.9	22.0	1.4	19.5	1.2
Di-n-octylphthalate	ND(15.4)	1.0	ND(16.0)	1.0	ND(15.5)	1.0	ND(15.7)	1.0	ND(15.6)	1.0	ND(15.8)	1.0	ND(15.5)	1.0	ND(15.8)	1.0	ND(16.0)	1.0	ND(16.0)	1.0	ND(15.8)	1.0	ND(15.4)	0.9	ND(15.7)	1.0	ND(16.2)	1.0
Diethylphthalate	ND(15.4)	1.7	ND(16.0)	1.7	ND(15.5)	1.7	ND(15.7)	1.7	ND(15.6)	1.7	ND(15.8)	1.7	ND(15.5)	1.7	ND(15.8)	1.7	ND(16.0)	1.7	ND(16.0)	1.7	ND(15.8)	1.7	ND(15.4)	1.7	ND(15.7)	1.7	ND(16.2)	1.8
Methylnaphthalenes	296.4	50.1	127.6	21.6	74.3	12.6	59.6	10.1	65.5	11.1	170.1	28.8	52.6	8.9	41.0	6.9	41.6	7.0	34.8	5.9	184.3	31.2	201.4	34.1	133.0	22.5	ND(16.2)	2.5
N-Nitroso di-n-propylamine	ND(15.4)	2.9	ND(16.0)	2.9	ND(15.5)	2.9	ND(15.7)	2.9	ND(15.6)	2.9	ND(15.8)	2.9	ND(15.5)	2.9	ND(15.8)	2.9	ND(16.0)	3.0	ND(16.0)	3.0	ND(15.8)	2.9	ND(15.4)	2.8	ND(15.7)	2.9	ND(16.2)	3.0
N-Nitrosodiphenylamine	40.1	4.9	25.5	3.1	31.0	3.8	37.7	4.6	15.6	1.9	25.2	3.1	ND(15.5)	1.9	ND(15.8)	1.9	38.4	4.7	31.6	4.7	31.6	4.7	24.6	3.0	31.5	3.8	19.5	2.4
Naphthalene	188.3	35.3	111.7	20.9	74.3	13.9	72.2	13.5	71.7	13.4	144.9	27.2	49.5	9.3	47.3	8.9	57.5	10.8	47.4	10.8	47.4	10.8	122.9	23.1	151.1	28.3	87.6	16.4
Phenanthrene	ND(15.4)	2.1	ND(16.0)	2.2	ND(15.5)	2.1	ND(15.7)	2.1	ND(15.6)	2.1	ND(15.8)	2.1	ND(15.5)	2.1	ND(15.8)	2.1	ND(16.0)	2.2	ND(16.0)	2.2	ND(15.8)	2.1	ND(15.4)	2.1	ND(15.7)	2.1	ND(16.2)	2.2
Phenol	605.1	154.6	108.5	27.7	61.9	15.8	34.5	8.8	43.6	11.1	122.9	31.4	77.3	19.7	82.1	21.0	54.4	13.9	56.9	13.9	56.9	13.9	451.7	115.4	327.4	83.6	253.1	64.7

ND - Not detected; parenthetical value is PQL.

Table 4.52 (continued)
SVOC Concentrations
Ambient Locations
Tinker AFB, Oklahoma

ANALYTE	A1		A2		A3		A4		A5		A6		Station Locations		A7		A8		A9†		A10		A11		A12		A13	
	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv	ng/m³	pptv
Sample Date: 11/08/93																												
1,2-Dichlorobenzene	28.2	4.6	ND(15.8)	2.6	ND(15.5)	2.5	ND(15.7)	2.6	ND(15.8)	2.6	ND(15.4)	2.5	ND(15.5)	2.5	ND(15.2)	2.5					57.6	9.4	ND(15.3)	2.5	18.2	3.0	ND(15.7)	2.6
1,3-Dichlorobenzene	ND(15.7)	2.6	ND(15.8)	2.6	ND(15.5)	2.5	ND(15.7)	2.6	ND(15.8)	2.6	ND(15.4)	2.5	ND(15.5)	2.5	ND(15.2)	2.5					ND(15.2)	2.5	ND(15.3)	2.5	ND(15.2)	2.5	ND(15.7)	2.6
1,4-Dichlorobenzene	ND(15.7)	2.6	18.9	3.1	65.2	10.7	ND(15.7)	2.6	ND(15.8)	2.6	ND(15.4)	2.5	ND(15.5)	2.5	ND(15.2)	2.5					24.2	4.0	ND(15.3)	2.5	ND(15.2)	2.5	ND(15.7)	2.6
Bis(2-ethylhexyl)phthalate	ND(15.7)	1.0	ND(15.8)	1.0	24.8	1.5	25.1	1.5	22.2	1.4	21.6	1.3	ND(15.5)	1.0	ND(15.2)	0.9					ND(15.2)	0.9	ND(15.3)	0.9	ND(15.2)	0.9	ND(15.7)	1.0
Di-n-butylphthalate	191.1	16.5	224.1	19.4	341.5	29.5	407.1	35.2	234.5	20.2	401.1	34.6	124.0	10.7	ND(15.2)	1.3					ND(15.2)	1.3	ND(15.3)	1.3	ND(15.2)	1.3	ND(15.7)	1.4
Di-n-octylphthalate	ND(15.7)	1.0	ND(15.8)	1.0	ND(15.5)	1.0	ND(15.7)	1.0	ND(15.8)	1.0	ND(15.4)	0.9	ND(15.5)	1.0	ND(15.2)	0.9					ND(15.2)	0.9	ND(15.3)	0.9	ND(15.2)	0.9	ND(15.7)	1.0
Diethylphthalate	ND(15.7)	1.7	ND(15.8)	1.7	ND(15.5)	1.7	ND(15.7)	1.7	ND(15.8)	1.7	ND(15.4)	1.7	ND(15.5)	1.7	ND(15.2)	1.6					ND(15.2)	1.6	ND(15.3)	1.7	ND(15.2)	1.6	ND(15.7)	1.7
Methylnaphthalenes	225.6	38.1	123.1	20.8	77.6	13.1	87.7	14.8	79.2	13.4	64.8	11.0	27.9	4.7	39.6	6.7					151.5	25.6	150.0	25.4	133.7	22.6	53.4	9.0
N-Nitroso di-n-propylamine	ND(15.7)	2.9	ND(15.8)	2.9	ND(15.5)	2.9	ND(15.7)	2.9	ND(15.8)	2.9	ND(15.4)	2.8	ND(15.5)	2.9	ND(15.2)	2.8					ND(15.2)	2.8	ND(15.3)	2.8	ND(15.2)	2.8	ND(15.7)	2.9
N-Nitrosodiphenylamine	ND(15.7)	1.9	ND(15.8)	1.9	ND(15.5)	1.9	ND(15.7)	1.9	ND(15.8)	1.9	ND(15.4)	1.9	ND(15.5)	1.9	ND(15.2)	1.8					ND(15.2)	1.8	ND(15.3)	1.9	ND(15.2)	1.8	ND(15.7)	1.9
Naphthalene	131.6	24.7	104.2	19.5	108.7	20.4	109.6	20.6	104.6	19.6	98.7	18.5	43.4	8.1	51.8	9.7					106.1	19.9	94.9	17.8	103.4	19.4	47.1	8.8
Phenanthrene	ND(15.7)	2.1	ND(15.8)	2.1	ND(15.5)	2.1	ND(15.7)	2.1	ND(15.8)	2.1	ND(15.4)	2.1	ND(15.5)	2.1	ND(15.2)	2.1					ND(15.2)	2.0	ND(15.3)	2.1	ND(15.2)	2.0	ND(15.7)	2.1
Phenol	303.9	77.6	56.8	14.5	34.2	8.7	25.1	6.4	25.3	6.5	21.6	5.5	ND(15.5)	4.0	21.3	5.5					227.3	58.1	156.1	39.9	124.6	31.8	50.2	12.8

4/50RB/7/14/10p-1108.mlx

ND - Not detected; parenthetical value is PQL.
+ - No data indicates sample not collected or invalid.

Table 4.53
 Phenol Concentrations, $\mu\text{g}/\text{M}^3$
 Flux and Probe Source Locations
 Phase A
 Tinker AFB, Oklahoma

DATE	S2-1†		S2-2†		S3†		S5-1†		S5-2†		S9†		S12†	
	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe
09/22/93	19802	165 *	17424	332	162 *	161 *	161 *	163 *	157 *	159 *	154 *	208 *	161 *	158 *
09/23/93														
09/24/93	12690	157 *	15163	155 *	153 *	156 *	157 *	159 *	149 *	147 *	3963	4673	154 *	159 *
09/27/93	13678		12333		153 *		156 *		155 *		157 *		154 *	
09/29/93													154 *	

450RB/123r34/au401/mast_slf.wk3

* - Not detected; reported value is PQL.
 † - No data indicates sample not collected or invalid.

Table 4.54
Phenol Concentrations, $\mu\text{g}/\text{M}^3$
Probe Source Locations
Phase A
Tinker AFB, Oklahoma

DATE	Station Locations										
	S6-1 †	S8 †	S11 †	S13 †	S16 †	S19 †	S20-2 †	S21 †	S22 †	S23 †	
09/22/93	161 *										
09/23/93		158 *	158 *			156 *	157 *	159 *	158 *	154 *	
09/25/93				154 *	151 *						
09/27/93	157 *	159 *	161 *	6619							
09/28/93					158 *	158 *		152 *	156 *	157 *	
09/29/93		156 *	154 *	157 *	156 *	156 *					
09/30/93	158 *										

450RB/123r34/au401/mast_sbpwk3

* - Not detected; reported value is PQL.
† - No data indicates sample not collected or invalid.

Table 4.55
 Phenol Concentrations, $\mu\text{g}/\text{M}^3$
 Flux Source Locations
 Phase B
 Tinker AFB, Oklahoma

DATE	Station Locations				
	S2-1 †	S2-2 †	S3	S5-2	S9
10/01/93		8783	2719	161 *	163 *
10/04/93		7854	155 *	156 *	158 *
10/06/93		8967	1296	448	158 *
10/08/93		10992	1552	516	416
10/11/93		387944	1821	153 *	156 *
10/13/93		7338	337	155 *	341
10/15/93		7049	159 *	160 *	163 *
10/18/93		5318	558	512	164 *
10/20/93		5085	157 *	158 *	161 *
10/25/93		4276	390	206	521
10/27/93		2221	376	274	155 *
10/29/93		1942	181	565	155
11/01/93		2382	197	260	441
11/02/93	6054		353	279	349
11/04/93	7615		869	990	1441
11/06/93	1431		275	278	477
11/08/93	3537		315	561	857

450RB/123B4/au401/mast_sl.wk3

* – Not detected; reported value is PQL.

† – No data indicates sample not collected or invalid.

Table 4.56
Ambient Phenol Concentrations, $\mu\text{g}/\text{M}^3$
Tinker AFB, Oklahoma

DATE	Station Locations												
	A1	A2	A3	A4	A5	A6	A7	A8	A9 †	A10	A11	A12 †	A13 †
09/22/93	111 *	117 *	116 *	111 *	122 *	111 *	108 *	111 *	125 *	112 *	114 *	116 *	113 *
09/24/93	107 *	112 *	111 *	111 *	125 *	112 *	103 *	106 *	117 *	109 *	109 *	109 *	107 *
09/27/93	109 *	115 *	114 *	115 *	128 *	116 *	110 *	113 *	126 *	117 *	112 *	121 *	143 *
09/29/93	109 *	114 *	113 *	114 *	128 *	115 *	110 *	130 *	119 *	111 *	112 *		
10/01/93	109 *	114 *	113 *	114 *	128 *	115 *	110 *	113 *	125 *	116 *	111 *	119 *	116 *
10/04/93	110 *	116 *	115 *	113 *	153 *	114 *	111 *	112 *	124 *	115 *	113 *	118 *	115 *
10/07/93	114 *	111 *	110 *	110 *	126 *	111 *	102 *	105 *	116 *	108 *	108 *	108 *	105 *
10/08/93	106 *	111 *	111 *	111 *	124 *	112 *	107 *	110 *	121 *	112 *	109 *	113 *	111 *
10/12/93	106 *	112 *	111 *	112 *	125 *	113 *	108 *	111 *	123 *	115 *	109 *	117 *	114 *
10/13/93	103 *	108 *	107 *	129 *	120 *	108 *	103 *	106 *	117 *	110 *	105 *	113 *	
10/15/93	108 *	114 *	113 *	114 *	128 *	116 *	111 *	114 *	125 *	116 *	111 *	118 *	115 *
10/18/93	110 *	116 *	115 *	116 *	130 *	118 *	113 *	119 *	132 *	123 *	113 *	112 *	109 *
10/20/93	102 *	108 *	107 *	108 *	121 *	109 *	104 *	107 *	117 *	110 *	105 *	110 *	108 *
10/25/93	103 *	109 *	108 *	109 *	122 *	110 *	105 *	108 *	119 *	110 *	107 *	112 *	109 *
10/27/93	100 *	105 *	105 *	105 *	118 *	106 *	101 *	104 *	115 *	108 *	103 *	109 *	106 *
10/29/93	99 *	104 *	104 *	101 *	113 *	103 *	100 *	101 *	111 *	104 *	102 *	106 *	103 *
11/01/93	105 *	111 *	110 *	111 *	124 *	112 *	107 *	110 *	121 *	113 *	109 *	114 *	111 *
11/02/93	317 *	344 *	353 *	451 *	385 *	347 *	351 *	319 *	516 *	262 *	356 *	370 *	414 *
11/04/93	223 *	290 *	277 *	356 *	449 *	359 *	278 *	430 *	523 *	420 *	272 *	354 *	356 *
11/06/93	245 *	216 *	296 *	350 *	369 *	312 *	178 *	356 *	405 *	337 *	281 *	394 *	250 *
11/08/93	308 *	270 *	286 *	278 *	393 *	302 *	318 *	382 *		319 *	294 *	328 *	329 *

4508R B1 2x34au-01/mast_al.wk3

* - Not detected; reported value is PQL.

† - No data indicates sample not collected or invalid.

Table 4.57
Process Exposure Phenol Concentrations, $\mu\text{g}/\text{M}^3$
Tinker AFB, Oklahoma

DATE	Station Locations									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
09/22/93	126 *	127 *	122 *	116 *	124 *	117 *	121 *	136 *	155 *	124 *
09/24/93	104 *	106 *	104 *	104 *	110 *	103 *	107 *	116 *	137 *	107 *
09/27/93	109 *	113 *	110 *	110 *	115 *	108 *	113 *	121 *	142 *	160 *
09/29/93	107 *	110 *	108 *	107 *	93 *	106 *	110 *	119 *	139 *	109 *
10/01/93	113 *	117 *	114 *	114 *	120 *	114 *	119 *	129 *	151 *	118 *
10/04/93	113 *	117 *	115 *	114 *	121 *	114 *	119 *	129 *	152 *	119 *
10/07/93	104 *	108 *	105 *	104 *	110 *	103 *	106 *	115 *	134 *	104 *
10/08/93	108 *	112 *	109 *	108 *	114 *	107 *	111 *	120 *	140 *	110 *
10/12/93	110 *	114 *	112 *	111 *	117 *	110 *	114 *	123 *	145 *	113 *
10/13/93	105 *	109 *	107 *	106 *	112 *	105 *	110 *	119 *	139 *	109 *
10/15/93	113 *	117 *	114 *	114 *	121 *	114 *	113 *	122 *	144 *	112 *
10/18/93	119 *	123 *	121 *	120 *	127 *	120 *	118 *	128 *	151 *	118 *
10/20/93	106 *	109 *	107 *	106 *	112 *	105 *	108 *	117 *	137 *	108 *
10/25/93	106 *	109 *	107 *	106 *	111 *	105 *	109 *	117 *	137 *	107 *
10/27/93	103 *	107 *	104 *	104 *	109 *	103 *	107 *	116 *	136 *	106 *
10/29/93	100 *	103 *	101 *	100 *	105 *	99 *	103 *	112 *	131 *	102 *
11/01/93	106 *	110 *	107 *	106 *	112 *	105 *	109 *	117 *	138 *	107 *
11/02/93	341 *	406 *	344 *	371 *	380 *	418 *	458 *	425 *	499 *	306 *
11/04/93	307 *	339 *	420 *	428 *	467 *	386 *	458 *	421 *	451 *	340 *
11/06/93	392 *	468 *	395 *	403 *	340 *	350 *	403 *	436 *	367 *	349 *
11/08/93	385 *	357 *	357 *	325 *	384 *	331 *	302 *	293 *	443 *	345 *

450RB/12334/au401/mast_pl.wk3

* -- Not detected; reported sample is PQL.

Table 4.58
 Formaldehyde Concentrations, $\mu\text{g}/\text{M}^3$
 Flux and Probe Source Locations
 Phase A
 Tinker AFB, Oklahoma

DATE	Station Locations											
	S2-1†		S2-2†		S3†		S5-1†		S5-2†		S9†	
	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe	Flux	Probe
09/22/93	165.5 *	161.8 *	295.5	163.0 *	990.8	161.1 *	159.5 *	160.8 *	162.6 *	161.7 *	160.3 *	207.5 *
09/23/93												
09/24/93	155.9 *	159.6 *	157.4 *	153.8 *	159.0 *	158.5 *	155.7 *	157.0 *	149.1 *	154.9 *	155.7 *	155.0 *
09/27/93	156.3 *		150.9 *		155.9 *		154.5 *		153.8 *		154.4 *	
09/29/93												
											161.8 *	160.8 *
											160.3 *	162.1 *
											153.2 *	

450RB/123134au401/mast_5 ffwk3

* - Not detected; reported value is PQL
 † - No data indicates sample not collected or invalid.

Table 4.59
 Formaldehyde Concentrations, $\mu\text{g}/\text{M}^3$
 Probe Source Locations
 Phase A
 Tinker AFB, Oklahoma

DATE	Station Locations									
	S6-1 †	S8 †	S11 †	S13 †	S16 †	S19 †	S20-2 †	S21 †	S22 †	S23 †
09/22/93	160.3 *									
09/23/93		156.9 *	160.3 *			158.9 *	161.7 *	156.1 *	161.2 *	160.0 *
09/25/93				156.7 *	157.1 *					
09/27/93	159.7 *	157.9 *	159.0 *	158.6 *						
09/28/93					155.1 *	156.5 *		158.2 *	155.6 *	159.3 *
09/29/93		154.2 *	153.2 *	153.9 *	153.8 *	154.3 *				
09/30/93	156.1 *									

450RB/123r34/au401/mast_sfp.wk3

* - Not detected; reported value is PQL.

† - No data indicates sample not collected or invalid.

Table 4.60
Ambient Formaldehyde Concentrations, $\mu\text{g}/\text{M}^3$
Tinker AFB, Oklahoma

Date	Station Locations												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12 †	A13 †
09/22/93	8.0 *	8.0 *	8.0 *	7.4 *	7.6 *	7.7 *	7.8 *	7.5 *	7.8 *	7.8 *	8.2 *	7.8 *	7.8 *
09/24/93	7.7 *	7.7 *	7.7 *	7.4 *	7.7 *	7.7 *	7.4 *	7.2 *	7.3 *	7.7 *	7.9 *	7.3 *	7.4 *
09/27/93	7.9 *	7.9 *	7.9 *	7.7 *	8.0 *	8.0 *	7.9 *	7.7 *	7.8 *	8.2 *	8.0 *	8.1 *	9.9 *
09/29/93	7.8 *	7.8 *	7.9 *	7.6 *	7.9 *	7.9 *	7.9 *	8.8 *	7.4 *	7.8 *	8.0 *		
10/01/93	7.8 *	7.8 *	7.8 *	7.6 *	7.9 *	7.9 *	7.9 *	7.7 *	7.7 *	8.1 *	8.0 *	8.0 *	8.0 *

450RBM123r34au401\mast_af.wk3

* - Not detected, reported value is PQL

† - No data indicates sample not collected or invalid.

Table 4.61
Process Exposure Formaldehyde Concentrations, $\mu\text{g}/\text{M}^3$
Tinker AFB, Oklahoma

DATE	Station Locations									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
09/22/93	9.0 *	8.7 *	8.7 *	89.6	8.4 *	7.9 *	8.3 *	10.2	108.6	12.9
09/24/93	13.4	7.3 *	7.4 *	7.3 *	7.4 *	7.0 *	7.4 *	7.3 *	8.7 *	7.4 *
09/27/93	10.1	7.7 *	7.8	33.9	8.6	7.3	7.7 *	7.6 *	9.0 *	25.5
09/29/93	7.6 *	7.6 *	7.7 *	7.5 *	6.3 *	7.2 *	7.5 *	7.5 *	8.8 *	10.6
10/01/93	8.1 *	8.0 *	8.1 *	8.0 *	8.2 *	13.1	8.1 *	8.1 *	9.6 *	8.2 *

* - Not detected; reported value is PQL.

450RB/123134/au401/mast_pf.wk3

Table 4.62
H₂S concentrations, $\mu\text{g}/\text{M}^3$
Ambient Locations*
Tinker AFB, Oklahoma

Sample Date	Sample Set	A1	A2	A3	A7	A11	A12	A13
10/25/93	First	4.6	4.5	4.6	4.6	4.6	4.7	4.7
	Second	4.7	4.7	4.7	4.7	4.8	4.8	4.8
10/27/93	First	4.4	4.4	4.4	4.4	4.5	4.5	4.4
	Second	4.5	4.5	4.5	4.5	4.6	4.6	4.5
10/29/93	First	4.3	4.4	4.5	4.6	3.5	4.8	4.4
	Second	4.3	4.3	4.4	4.6	5.1	4.7	4.4
11/01/93	First	4.4	4.4	4.5	4.7	5.2	4.8	4.5
	Second	4.4	4.4	4.5	4.7	5.3	4.9	4.5
11/02/93	First	4.5	4.6	4.7	4.9	5.4	5.0	4.6
	Second	4.5	4.6	4.7	4.9	5.4	5.0	4.6
11/04/93	First	4.7	4.8	4.9	5.1	5.6	5.2	4.8
	Second	4.7	4.7	4.8	5.1	5.6	5.2	4.8
11/06/93	First	4.2	4.2	4.3	4.5	5.0	4.6	4.3
	Second	4.2	4.3	4.4	4.6	5.1	4.7	4.3
11/08/93	First	4.4	4.5	4.6	4.8	5.3	4.9	4.5
	Second	4.4	4.5	4.6	4.8	5.3	4.9	4.5
11/09/93	First	4.5	4.5	4.6	4.7	5.3	4.8	4.4
	Second	4.5	4.5	4.6	4.8	5.3	4.9	4.6

450RB/123r34/au401/h2s.wk3

* – All reported values are PQL values.
No concentrations were detected at any location.

Table 4.63
 H₂S Concentrations Using Jerome Analyzer, ppb
 Process Exposure Locations
 Tinker AFB, Oklahoma

Sample Date	09/22/93	09/22/93†	10/06/93	10/07/93
Sample Time	1404 to 1530	1644 to 1650	0940 to 1024	1637 to 1653
Sample Location				
1-S	0.3	0	0	0
2-S	0	0	0	0
3-S	0		0	0
4-S	0.2	0	0	0
5-S	31.3		40	19
6-S	13.2	53	109	32
7-S	104	60	181	111
8-S	0	0	9	14
9-S	0		0	1
10-S	0		5	0
11-S	1.9	11	0	0
12-S	10	60	0	88
13-S	91	205	0	323
14-S	173	146	0	398
15-S	39	21	95	275

450RB/123r34/au401/jerome.wk3

† – No data indicates location not surveyed.

Table 4.64
Ambient TSP and Metal Concentrations, $\mu\text{g}/\text{M}^3$
Tinker AFB, Oklahoma

Sample Date	Analyte	Sample Location		
		P2	P3	P4
09/28/93	TSP	65.6	69.5	65.3
	Arsenic	0.0031 *	0.0033 *	0.0033 *
	Barium	0.0344	0.0401	0.0359
	Cadmium	0.0063 *	0.0067 *	0.0065 *
	Chromium	0.0500	0.0902	0.0392
	Lead	0.0313 *	0.0334 *	0.0326 *
	Mercury	0.0002	0.0001 *	0.0002
	Selenium	0.0313 *	0.0334 *	0.0326 *
	Silver	0.0031 *	0.0033 *	0.0033 *
09/30/93	TSP	102.2	100.2	96.7
	Arsenic	0.0025 *	0.0020 *	0.0022 *
	Barium	0.0397	0.0342	0.0394
	Cadmium	0.0050 *	0.0040 *	0.0044 *
	Chromium	0.0149	0.0161	0.0109
	Lead	0.0248 *	0.0201 *	0.0219 *
	Mercury	0.0002	0.0001	0.0001
	Selenium	0.0248 *	0.0201 *	0.0219 *
	Silver	0.0025 *	0.0020 *	0.0022 *
10/02/93	TSP	36.6	43.3	37.7
	Arsenic	0.0037 *	0.0040 *	0.0038 *
	Barium	0.0262	0.0277	0.0268
	Cadmium	0.0075 *	0.0079 *	0.0077 *
	Chromium	0.0187	0.0357	0.0230
	Lead	0.0374 *	0.0396 *	0.0384 *
	Mercury	0.0002	0.0002 *	0.0002
	Selenium	0.0374 *	0.0396 *	0.0384 *
	Silver	0.0037 *	0.0040 *	0.0038 *

* — Not detected; reported value is PQL

SECTION 5

AREA WIDE RESULTS

Section 4 presented the chemical analyses results for the samples collected from each SWMU. In this section, the analytical results from the investigation are discussed collectively across the WWTF in order to interpret the nature and extent of releases from the SWMUs. Comprehensive results from the WWTF investigations are presented for the following:

- Site geology
- Soil gas data
- Surface soil analytical data
- Stream sediment analytical data
- Air sampling data.

The site geology is presented first to describe the physical characteristics of the site. The soil gas and soil analytical data are then presented so that interpretations can be made regarding the distribution of contaminants. Influent lift station data are discussed to link the findings of the soil and sediment contaminant investigations with potential wastewater sources. Finally, the air sampling data describe ambient, process, and source conditions found in and around the WWTF.

5.1 SOIL, SEDIMENT, AND SOIL GAS

5.1.1 Geologic Investigations

As discussed in section 3, geologic investigations at the WWTF involved sampling surface soils, sediment, and subsurface soils. The following describes the physical characteristics of these media.

Surface Soils. In general, the surface soils are disturbed natural and fill materials that were distributed during the original construction and upgrade activities of the WWTF. Figure 4.3 illustrates the surface soil sampling locations across the WWTF. The surface soil around SWMUs 24.2 and 24.3 is mostly clay and silt (grass covered on the northern, western, and central areas, and gravel covered on the east side). The surface soil near RCP (non-SWMU) is silt and silty sand with gravel cover. The surface soil near SWMUs 32.1 and 32.3 and on the west side of SWMU 32.8 is predominantly clay and silty clay with grass cover. Surface soil on the east side of SWMU 32.8 and surrounding SWMU 24.19 is predominantly sand.

Stream Sediment. The sediments in East Soldier Creek have been deposited as a result of natural runoff from the surrounding area. Figure 4.1 shows the stream sediment sampling locations. Sediment compositions range from dark gray poorly sorted silts and gravels (at locations SE4 and SE5 in the vicinity of the IWTP effluent discharge) to black organic silts and muds on either end of the sampled stream reach (at locations SE1, 2, 3, and 6). Much of the sediment probably results from the accumulation and degradation of natural organic matter.

Subsurface Soils. Soil borings at the WWTF were drilled to a maximum depth of 20 feet bgs. Detailed lithologic descriptions for each boring can be found in appendix A. In general, interfingered lenses of sand, silt, and clay were encountered in the upper intervals of the borings. Unconsolidated to semi-consolidated layers of fine- and medium-grained sand usually were found in the deeper portion of each boring.

General correlations across the site are presented in geologic cross sections. The locations of the cross sections are shown on Figure 5.1; cross sections A-A' and B-B' are shown on Figures 5.2 and 5.3, respectively. Figure 5.1 also shows the locations of cross sections discussed later in this report.

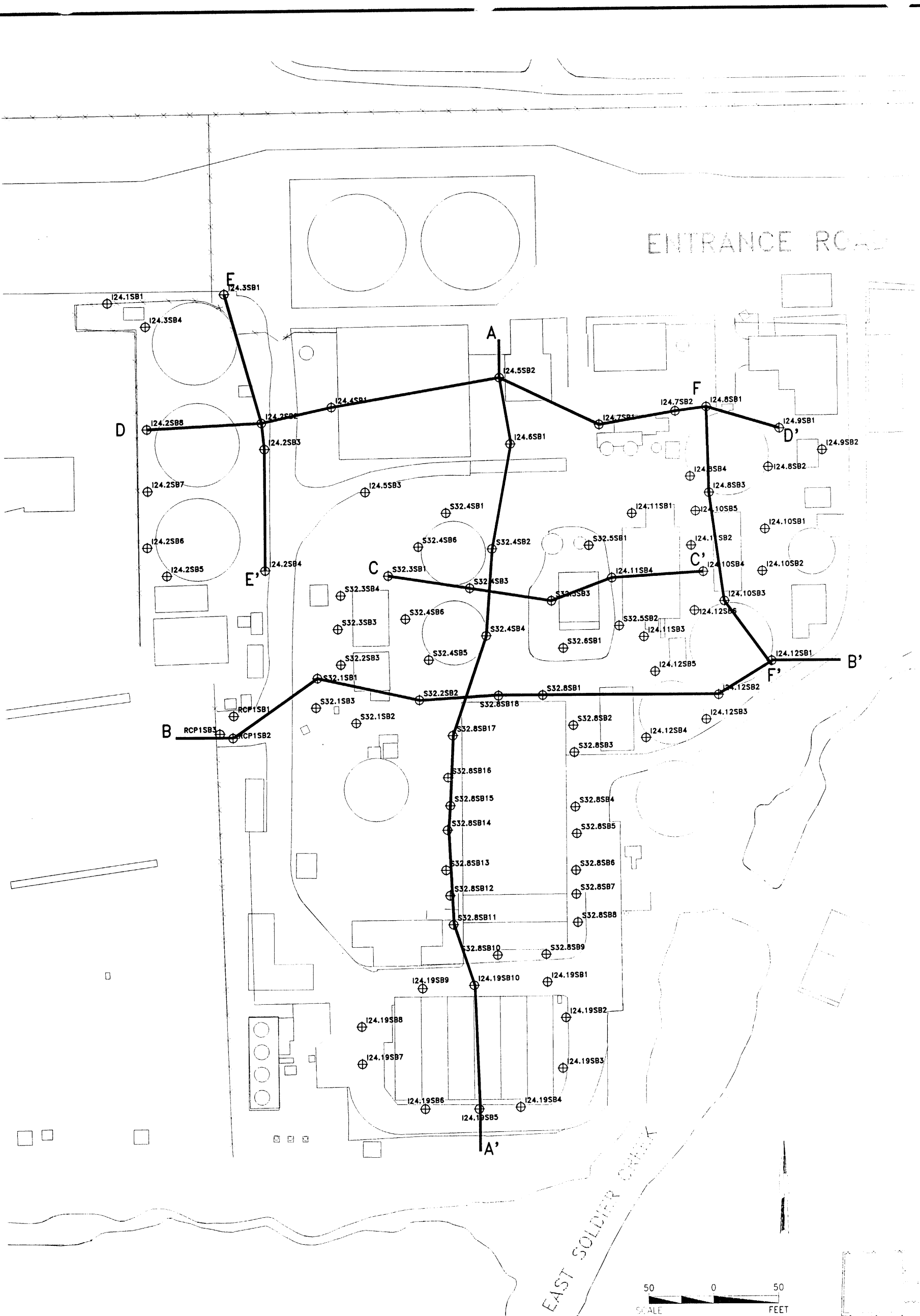
Cross section A-A' trends north to south and reveals a generally coarsening downward sequence of sediments. This sequence consists of dark-red clays and silts underlain by dark-red and yellow fine-grained silty sands becoming medium-grained with increasing depth. The medium-grained sands typically occur below the water table.

The upper section of clay and silt contains occasional fine-grained sand layers, and at some locations appears to be laminated. These upper sand layers are mostly discontinuous lenses and seams. The lower sand layers are well sorted and slightly cemented in layers. These sands consist of rounded to well-rounded quartz grains.

Cross section B-B' trends west to east and reveals the same general stratigraphy as cross section A-A'. A coarsening downward sequence ranges from clay and silt in the upper region to fine- to medium-grained sand in the lower region. Cross section B-B' also indicates that the sands are generally closer to the surface in the central portion of the site.

Forty-one geotechnical samples were collected from thirteen of the SWMUs across the WWTF. Thirty-two of the samples were undisturbed and nine were disturbed. Table 5.1 summarizes the results of the laboratory analysis. These results provide a representative profile of the geotechnical soil properties facility-wide. Figure 5.4 shows the boring locations and depths from which the geotechnical samples were collected.

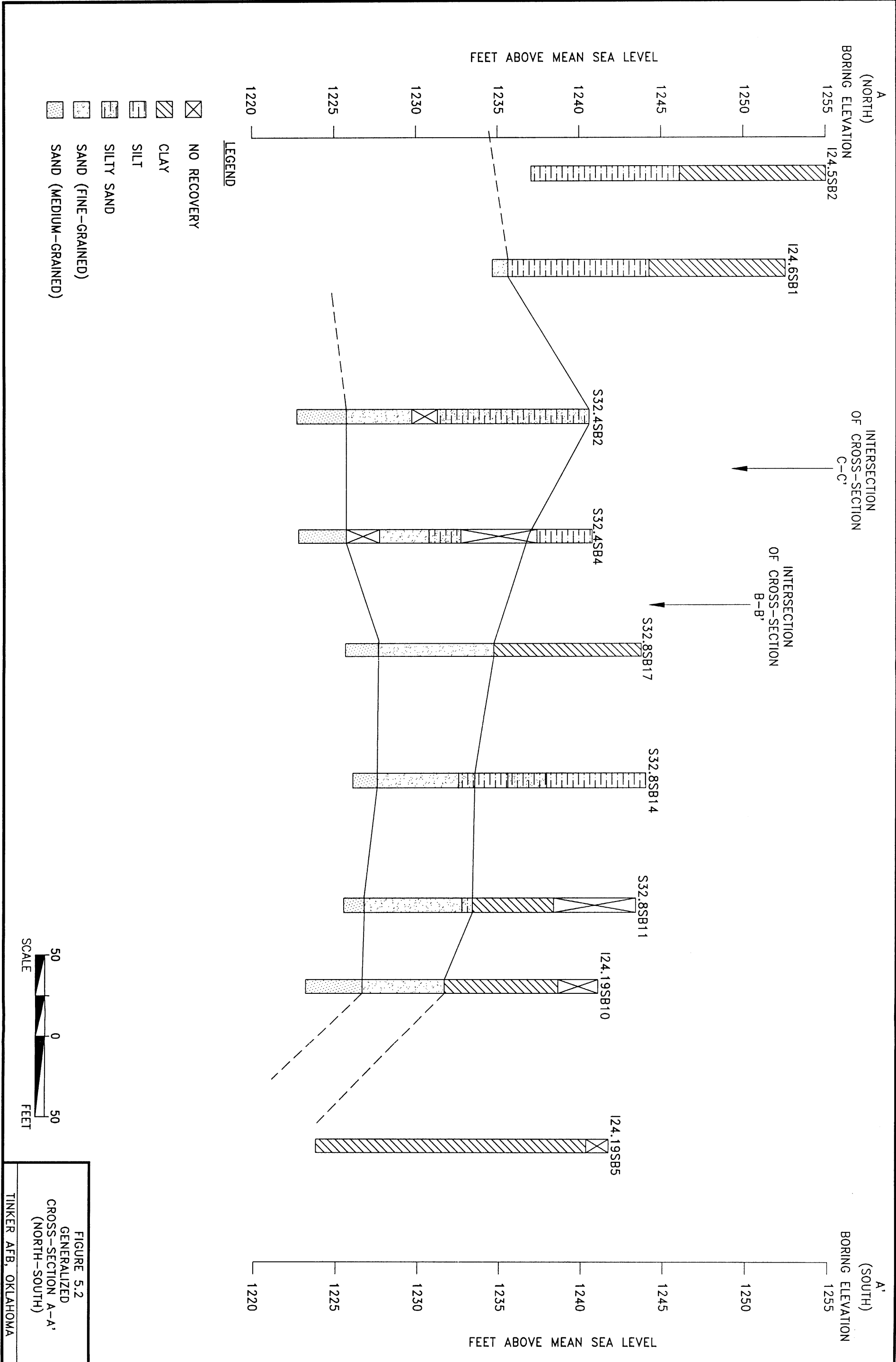
Most of the undisturbed samples were recovered in the upper soil horizon (0-12 feet bgs). Compacted and semiconsolidated sands found primarily in the deeper sampling horizons (12-18 feet bgs) did not allow recovery of undisturbed samples with Shelby tubes. Disturbed samples were recovered from the deeper horizons and submitted for limited geotechnical analysis.



- LEGEND**
- ⊕ SOIL BORING LOCATION
 - TANK
 - BUILDING OR TANK
 - ×—× FENCE
 - A — A' LINE OF SECTION

FIGURE 5.1
GEOLOGIC
CROSS-SECTION
LOCATION MAP

TINKER AFB, OKLAHOMA



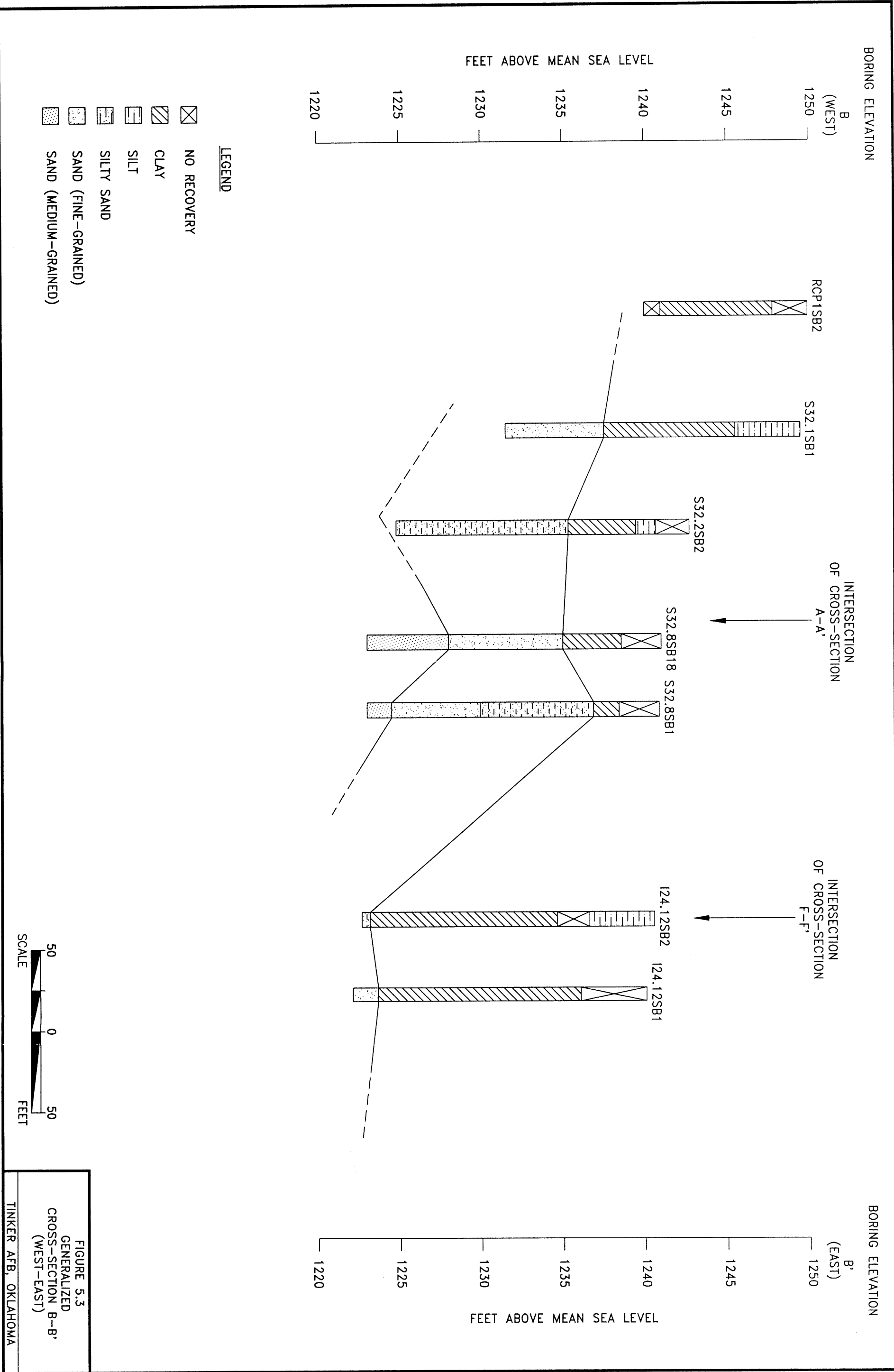


Table 5.1. Summary of Geotechnical Laboratory Results
IWTP and SWTP SWMUs
Tinker AFB, Oklahoma

Sample identification and depth	Description	USCS Classi- fication ¹	Atterberg Limits ²		Moisture content ³ (%)	Bulk density ⁴ (pcf.)	Organic Content ⁵ (%)	Constant head permeability ⁶ (cm/sec)	Particle Size Hydrometer		
			Liquid limit	Plastic limit					Plasticity index	Sand%	Silt%
Industrial Wastewater Treatment Plant SWMUs:											
24.1 Lift Station											
SB4 (13.5-15.0 ft.)	Reddish brown sandy SILT	ML	19	18	11.8	NA	1.9	NA	43	37	20
24.2 Tanks D-1 and D-2											
SB4 (4.0-6.0 ft.)	Red brown lean CLAY with sand	CL	31	20	19.4	112.6	5.6	4.5x10 ⁻⁸	16	38	46
24.3 Oil Separator											
SB1 (3.5-5.0 ft.)	Red and tan silty SAND	SM	NA	NA	18	111.9	1.7	2.9x10 ⁻⁶	62	32	6
24.4 Valve Vault											
SB1 (8.0-10.0 ft.)	Red brown clayey sandy SILT	ML	22	19	14.6	113.5	3.5	7.9x10 ⁻⁷	38	37	25
24.5 Equalization Basin											
SB2 (4.0-6.0 ft.)	Reddish brown silty CLAY	CL	45	24	18.6	111.9	4.7	3.6x10 ⁻⁸	1	28	71
24.8 Solids Clarifier											
SB1 (0.0-2.0 ft.)	Red brown clayey silty SAND	SC-SM	19	18	9.6	124.1	3.3	6.8x10 ⁻⁷	47	23	30
SB2 (4.0-6.0 ft.)	Red and tan poorly graded SAND with silt	SP-SM	NA	NA	4.9	NA	1.0	NA	91	5	4
SB3 (4.0-5.5 ft.)	Red brown silty SAND	SM	NA	NA	15.0	NA	4.0	NA	26	41	33
24.10 Softener Basins											
SB1 (2.0-4.0 ft.)	Red clayey silty SAND	SC-SM	19	NA	6.1	111.5	3.6	2.7x10 ⁻⁵	42	31	27
SB2 (4.0-6.0 ft.)	Red clayey silty SAND	SC-SM	20	19	14.6	116.1	3.0	1.7x10 ⁻⁶	44	32	24
SB3 (9.0-11.0 ft.)	Red brown clayey silty SAND	SM-SC	23	18	13.4	117.4	4.1	9.2x10 ⁻⁸	56	23	21
SB4 (4.0-4.8 ft.)	Red brown clayey SAND	SC	NA	NA	9.5	NA	3.5	NA	64	8	28

Table 5.1 continued

Sample identification and depth	Description	USCS Classi- fication	Atterberg Limits			Moisture content (%)	Bulk density (pcf.)	Organic Content (%)	Constant head permeability (cm/sec)	Particle Size Hydrometer		
			Liquid limit	Plastic limit	Plasticity index					Sand%	Silt%	Clay%
24.12 Secondary Clarifier												
SB1 (2.0-4.0 ft.)	Brown silty SAND	SM	NA	NA	NP	5.9	123.8	3.3	9.8x10 ⁻⁷	54	32	14
SB2 (4.0-6.0 ft.)	Red brown silty SAND	SM	18	18	NP	7.9	106.2	2.3	1.4x10 ⁻⁵	43	38	19
SB3 (8.0-8.5 ft.)	Red brown clayey silty SAND	SC-SM	20	17	3	12.1	109.1	2.5	2.3x10 ⁻⁵	48	27	25
SB4 (8.0-9.6 ft.)	Red brown silty SAND	SM	NA	NA	NP	10.4	107.0	1.5	2.8x10 ⁻⁵	63	20	17
24.19 Industrial Sludge Drying Beds												
SB4 (17.0-18.0 ft.)	Red brown clayey SAND	SC	23	17	6	18.7	111.7	3.6	3.9x10 ⁻⁷	56	21	23
SB8 (9.5-11.5 ft.)	Red silty SAND	SM	19	16	3	13.0	114.8	2.3	1.6x10 ⁻⁶	52	26	22
Sanitary Wastewater Treatment Plant SWMUs:												
32.1 Parshall Flume												
SB2 (10.0-12.0 ft.)	Red silty sandy CLAY	ML-CL	27	21	6	15.8	118.8	2.8	8.5x10 ⁻⁸	30	35	35
SB3 (4.0-6.0 ft.)	Red shaley lean CLAY	CL	43	20	23	12.7	100.9	4.8	2.7x10 ⁻⁸	11	38	51
32.2 Flocculation Chamber												
SB2 (0.0-2.0 ft.)	Red silty lean CLAY w/sand	CL	27	18	9	10.7	112.7	4.0	7.9x10 ⁻⁸	34	24	42
SB3 (4.0-6.0 ft.)	Brown clayey sandy SILT	ML	20	15	5	22.4	105.6	2.4	1.9x10 ⁻⁶	35	38	27
32.4 Trickling Filters												
SB2 (4.0-6.0 ft.)	Red silty sandy CLAY	ML-CL	NA	NA	NP	8.2	114.8	4.0	2.1x10 ⁻⁵	34	28	38
SB4 (6.0-8.0 ft.)	Red silty SAND	SM	NA	NA	NP	6.2	113.3	1.2	2.0x10 ⁻⁶	66	20	14
SB5 (3.0-5.0 ft.)	Reddish brown sandy SILT	ML	NA	NA	NP	8.8	NA	1.1	NA	42	49	9

Table 5.1 continued

Sample identification and depth	Description	USCS Classi- fication	Atterberg Limits		Moisture content (%)	Bulk density (pcf.)	Organic Content (%)	Constant head permeability (cm/sec)	Particle Size Hydrometer	
			Liquid limit	Plastic limit					Sand%	Silt% Clay%
32.8 Drying Beds										
SB1 (0.5-2.5 ft.)	Red clayey silty SAND	SC-SM	19	17	12.9	123.7	2.2	5.7x10 ⁻⁶	53	21 26
SB2 (2.0-4.0 ft.)	Red clayey silty SAND	SC-SM	19	NA	13.2	112.3	2.0	5.0x10 ⁻⁶	40	39 21
SB3 (4.0-6.0 ft.)	Red clayey silty SAND	SC-SM	NA	NA	10.9	111.3	2.0	1.0x10 ⁻⁵	54	22 24
SB4 (4.0-6.0 ft.)	Red brown sandy silty CLAY	ML-CL	27	20	17.2	111.3	3.0	1.0x10 ⁻⁶	42	30 28
SB5 (1.0-3.0 ft.)	Red brown sandy lean CLAY	CL	26	16	16.9	108.8	2.7	2.6x10 ⁻⁸	38	32 30
SB6 (6.0-8.0 ft.)	Red brown lean CLAY with sand	CL	24	16	17.1	109.6	3.5	3.1x10 ⁻⁷	25	50 25
SB7 (17.0-18.0 ft.)	Tan poorly graded SAND with silt	SP-SM	NA	NA	19.5	NA	0.8	NA	90	4 6
SB8 (13.0-14.0 ft.)	Red brown silty SAND	SM	NA	NA	15.4	NA	1.7	NA	74	12 14
SB9 (4.0-6.0 ft.)	Dark brown sandy lean CLAY	CL	34	17	15.8	118.8	4.7	7.1x10 ⁻⁸	38	28 34
SB10 (1.5-3.5 ft.)	Dark brown silty SAND with strong odor	SM	18	17	12.0	121.0	4.3	7.0x10 ⁻⁷	57	22 21
SB11 (0.5-2.5 ft.)	Red brown sandy SILT	ML	20	19	13.1	112.6	20	7.6x10 ⁻⁷	45	32 23
SB12 (0-2.0 ft.)	Brown lean CLAY with sand	CL	48	23	21.4	105.3	7.6	3.3x10 ⁻⁸	18	35 47
SB13 (2.0-4.0 ft.)	Red brown lean CLAY	CL	28	19	15.9	113.7	3.3	9.6x10 ⁻⁸	10	58 32
SB15 (2.5-4.0 ft.)	Red brown sandy SILT	ML	21	19	13.2	NA	3.2	NA	40	34 26
SB16 (0-2.0 ft.)	Red brown sandy lean CLAY	CL	27	19	9.1	NA	4.8	NA	40	32 28
SB18 (0.5-2.5 ft.)	Red brown sandy silty CLAY	CL	24	19	13.3	117.3	3.8	7.8x10 ⁻⁷	42	30 28

IWTP = Industrial Wastewater Treatment Plant

SWTP = Sanitary Wastewater Treatment Plant

SWMU = Solid Waste Management Unit

USCS = United Soil Conservation Service

pcf = pounds per cubic foot

NA = not applicable/not analyzed (disturbed sample)

NP = not performed

¹ ASTM D2487

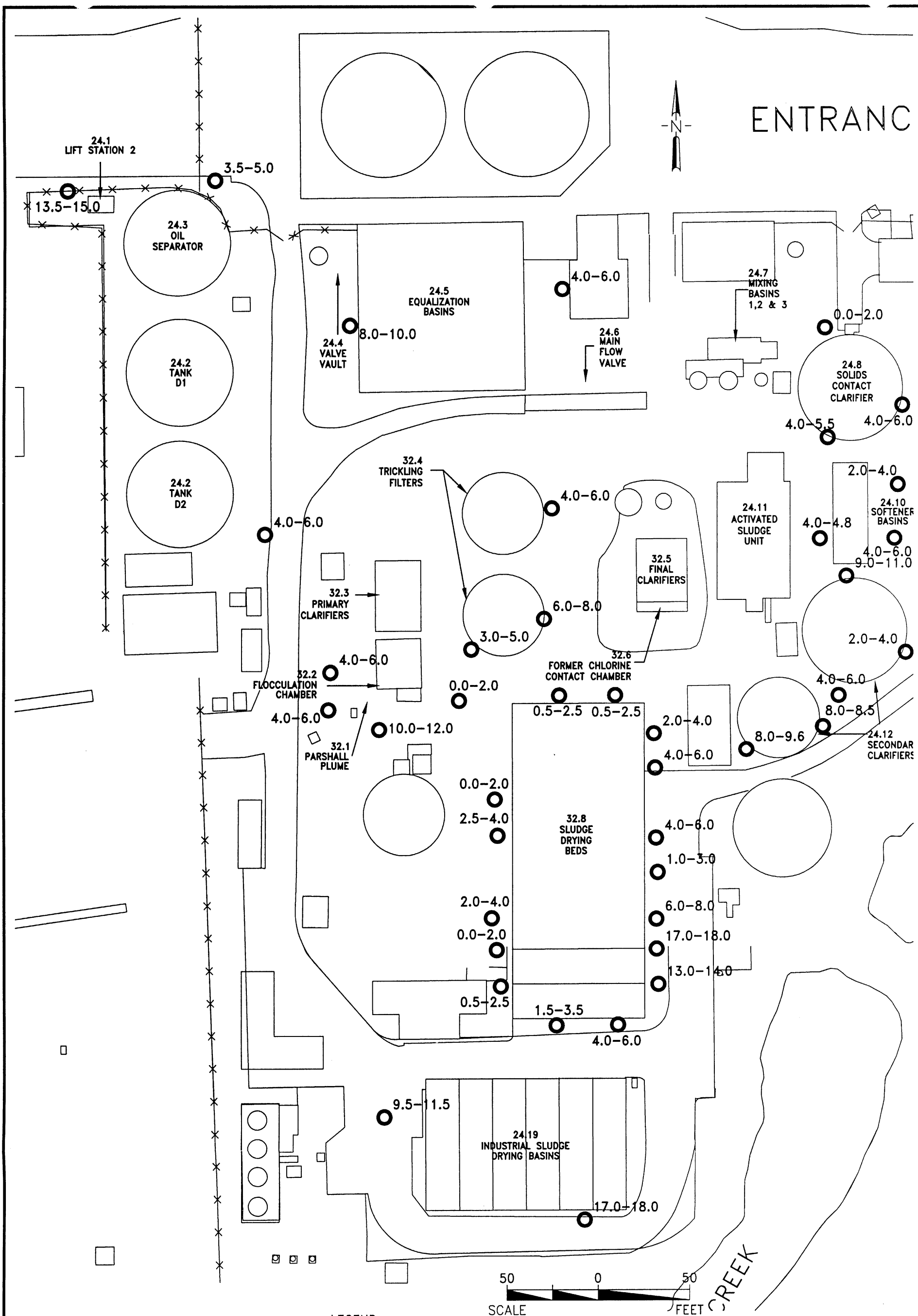
² ASTM D4318

³ ASTM D2216

⁴ ASTM D2937

⁵ ASTM D2970

⁶ ASTM D2434



5.1.2 Soil Gas Investigations

Results from the soil gas investigations indicate that two major VOC contaminant degradation chains, PCE and TCA, exist in the subsurface at the WWTF. The PCE degradation chain consists of PCE, TCE, 1,1-DCE, 1,2-DCE, and vinyl chloride. The TCA degradation chain consists of 1,1,1-TCA, 1,2-DCA, and 1,1-DCA. Figures 5.5 and 5.6 illustrate the extent of contaminant migration for the PCE and TCA chains, respectively, based on soil gas plumes. Each figure shows the distribution of the parent compound and its breakdown products that occur at concentrations equal to or greater than 1 ppmv. The location and concentration of 1,1,1-TCA is estimated because it could not be distinguished from 1,2-DCE in the soil gas analyses. For the same reason, 1,2-DCE results were omitted from Figure 5.5.

Figure 5.5 shows that all or most of the PCE degradation chain exists in the vicinity of:

- Blending tanks D-1 and D-2, and the oil separator tank (SWMUs 24.2 and 24.3, respectively)
- Recirculation pit (RCP)
- Inactive sludge drying beds (SWMU 24.19)

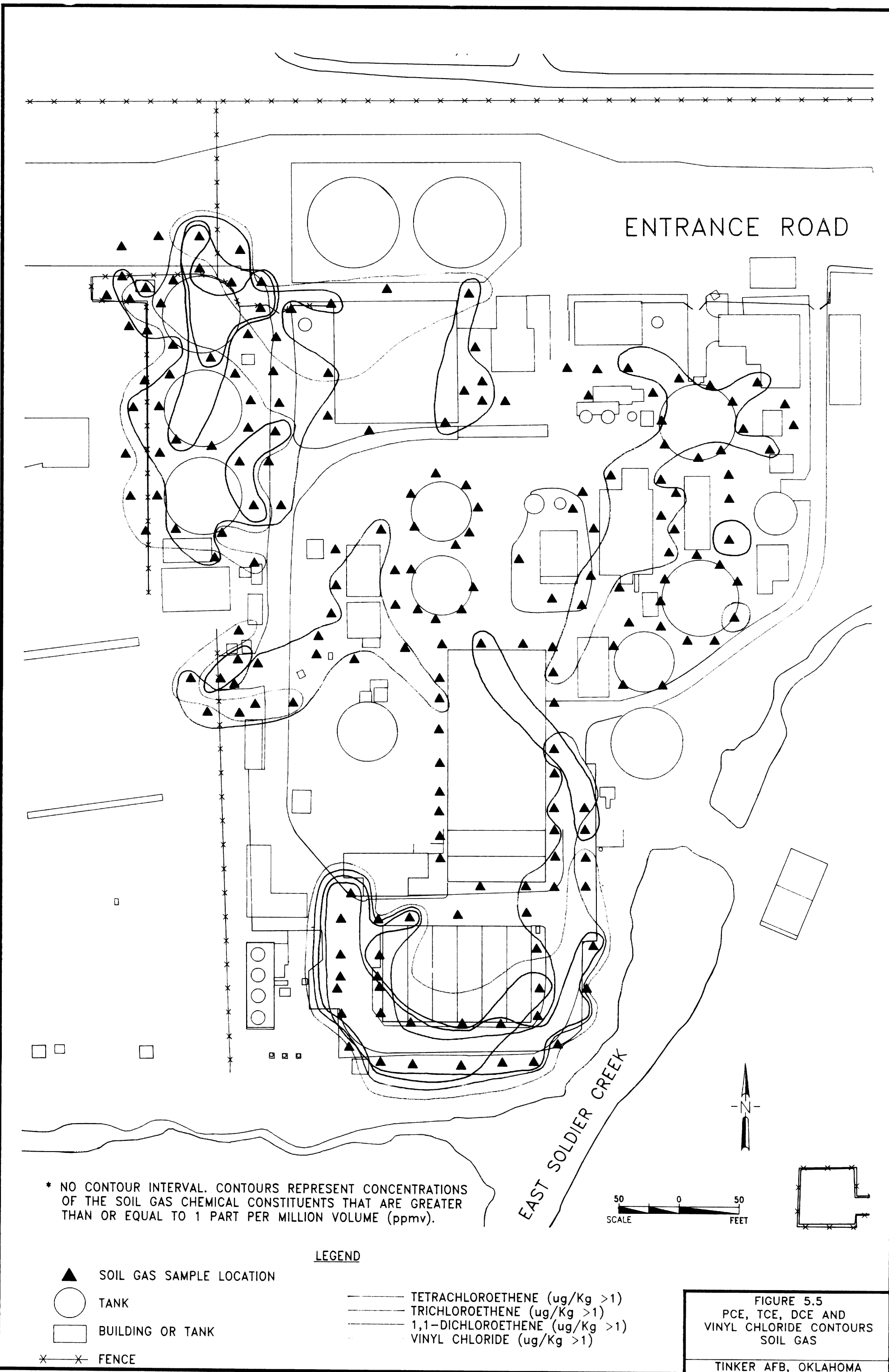
Significant levels of PCE and 1,1 DCE are evident at the southeastern end of the active sludge drying beds (SWMU 32.8). 1,1-DCE is fairly widespread around the equalization basins (SWMU 24.5), the main flow valve (SWMU 24.6), the activated sludge unit (SWMU 24.11), the sanitary flocculation chamber (SWMU 32.2), and the sanitary primary clarifiers (SWMU 32.3). Vinyl chloride was the most widespread contaminant in the soil gas when more than one compound was detected. The vinyl chloride is very mobile and migrates quickly. DCE was found at the greatest number of locations.

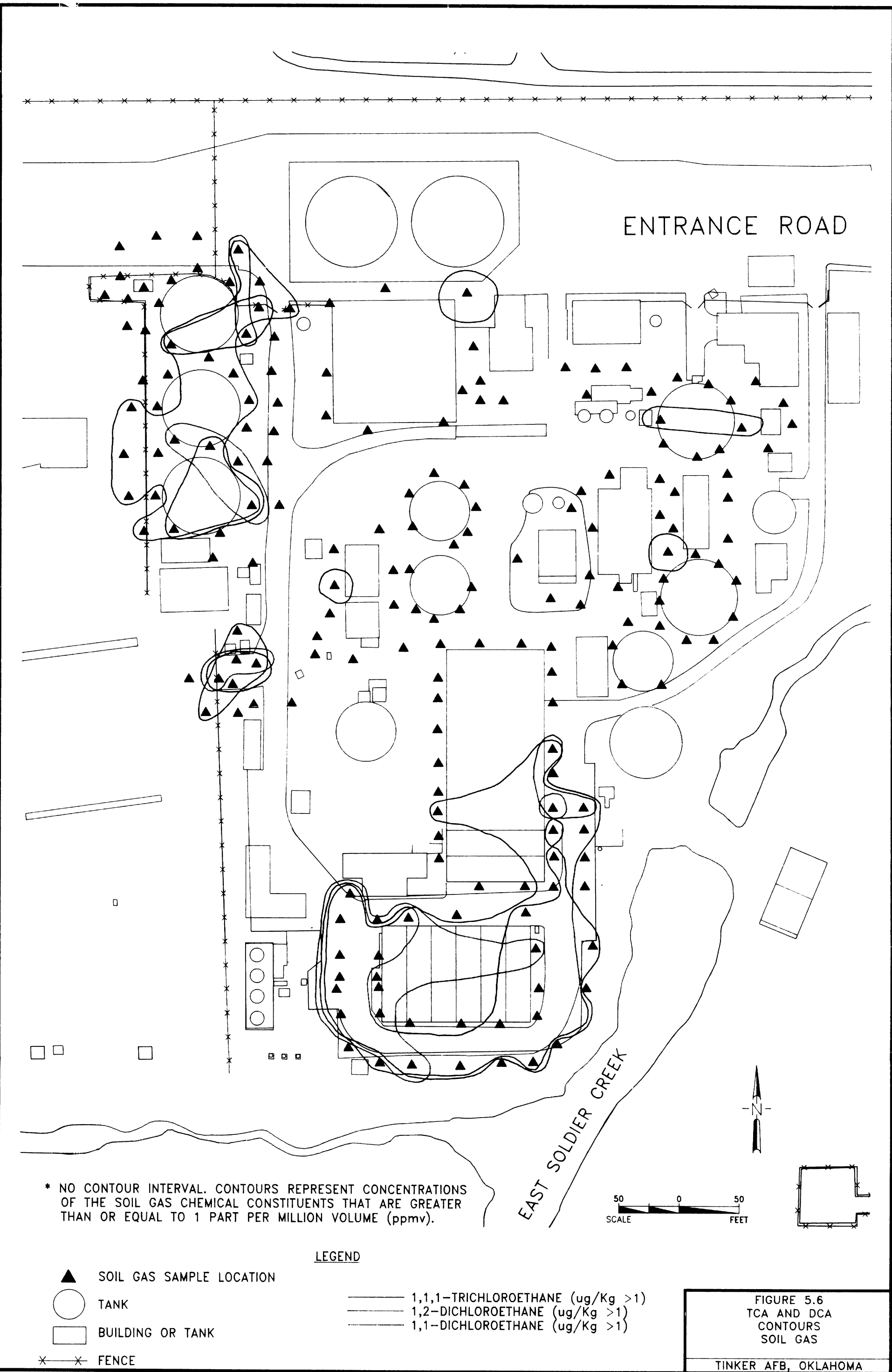
TCA degradation chain distribution (Figure 5.6) closely resembles the distribution of the PCE degradation chain, but is less extensive. The entire TCA chain is present at the same SWMUs as the PCE chain. The TCA chain also is present along the southeast side of the active sludge drying beds (SWMU 32.8). A limited area of 1,1,1-TCA contamination exists near the solids contact clarifier (SWMU 24.8).

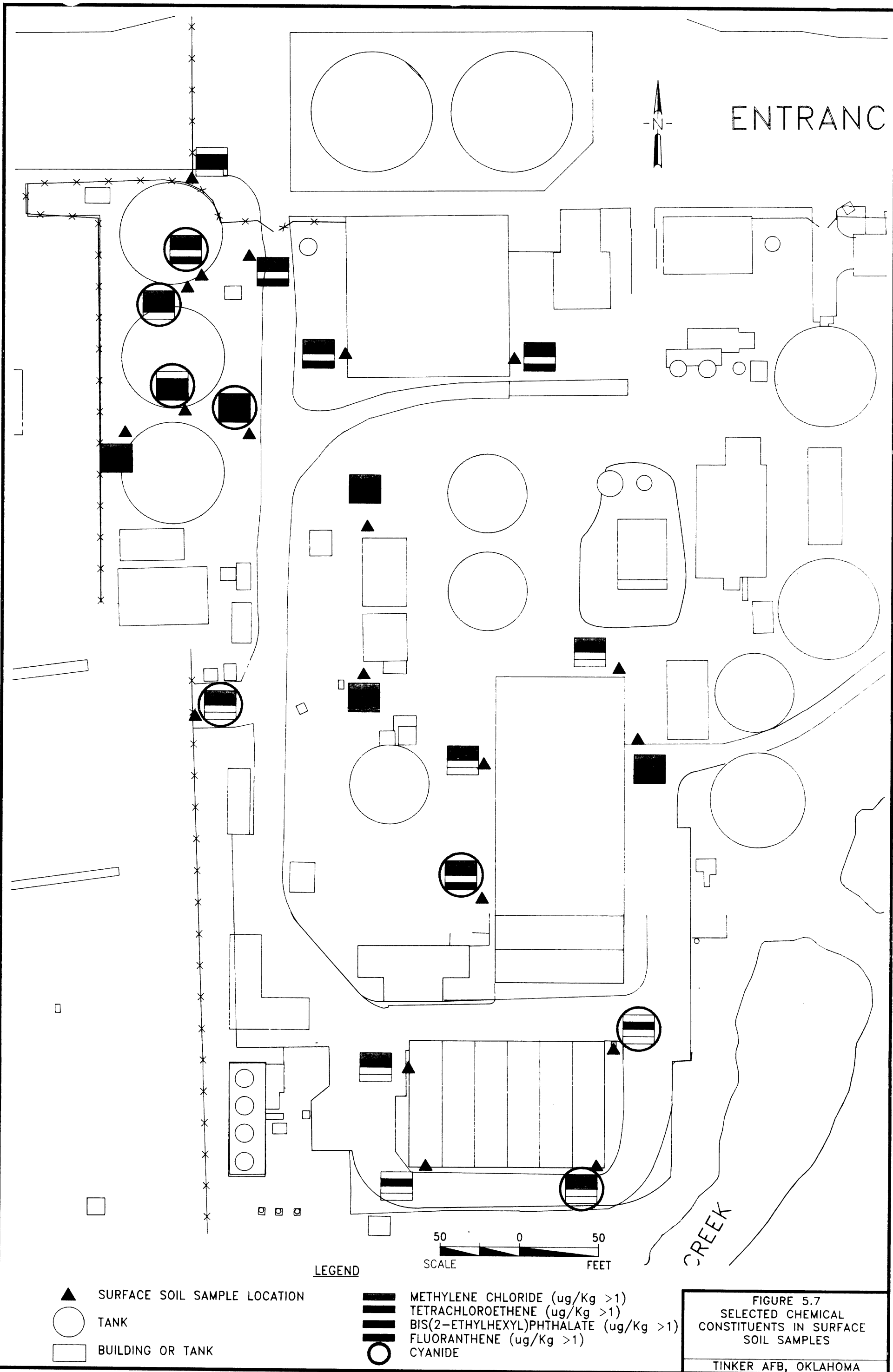
5.1.3 Surface Soils

The surface soils at the site have been tested for VOCs, SVOCs, PCBs, TPHs, metals, and cyanide. The contaminants detected above minimum detection limits and broadly distributed across the site are cyanide, methylene chloride, PCE, bis(2-ethylhexyl)phthalate, and fluoranthene. Figure 5.7 shows locations where these compounds were found above the detection limit.

The most pervasive organic contaminant detected in the surface soil is bis(2-ethylhexyl)phthalate, present in every sample collected at the site. The highest concentrations ranged from 8,850 $\mu\text{g/kg}$ at SWMU 24.2 to 210 $\mu\text{g/kg}$ at







SWMU 32.1. Bis(2-ethylhexyl)phthalate is a common plasticizer and the results may include false positives or have a high bias.

Although not detected in every sample, PCE is present in at least one sample from all of the SWMUs tested. The highest PCE concentrations range from 18 $\mu\text{g/kg}$ at SWMU 24.5 to 2.6 $\mu\text{g/kg}$ at SWMU 32.8. SWMUs 24.2 and 24.3 had average PCE concentrations of 4.4 $\mu\text{g/kg}$ and 4.6 $\mu\text{g/kg}$, respectively.

Methylene chloride was detected in surface soil at every SWMU sampled except 24.19. The highest concentrations of methylene chloride ranged from 40 $\mu\text{g/kg}$ at SWMU 24.5 to 2.8 $\mu\text{g/kg}$ at SWMU 32.8.

Fluoranthene was detected at every SWMU sampled except 24.3 and 24.5. The highest levels of fluoranthene ranged from 434 $\mu\text{g/kg}$ at SWMU 4.2 to 87.8 $\mu\text{g/kg}$ at SWMU 32.3.

Cyanide was also detected at every SWMU tested except 24.5, 32.1, and 32.3. The highest cyanide concentrations ranged from 5.43 $\mu\text{g/kg}$ at SWMU 24.2 to 0.94 $\mu\text{g/kg}$ at SWMU 32.8.

The average concentration was calculated for each metal at each SWMU. The soil profile was divided into surface soils (0-2 feet bgs), upper horizon (2-10 feet bgs), and lower horizon (10-18 feet bgs). Appendix G contains tables presenting the average concentrations, as well as the maximum and minimum concentrations for metals at each SWMU. The SWMU average metal concentrations are plotted along with the range of background concentration from samples collected near Tinker AFB (USGS, 1991) in Figures 5.8 through 5.17.

Many of the metals detected at concentrations above the background concentrations range were found in surface soils. The SWMU average surface soil cadmium concentration at SWMUs 24.2, 24.19, and RCP were 25 mg/kg, 20 mg/kg, and 37 mg/kg, respectively, well above the survey results of <2 mg/kg.

The highest SWMU average chromium concentrations, 414 mg/kg, 822 mg/kg, and 601 mg/kg, were detected in the surface soil samples from SWMUs 24.2, 24.19, and 32.8, respectively. The highest total chromium concentrations were 945 mg/kg (SWMU 24.2), 2,650 mg/kg (SWMU 24.19), and 3,050 mg/kg (SWMU 32.8). Lead, nickel, silver, and zinc SWMU average concentrations were significantly above the survey background range at SWMUs 24.2, 24.3, 24.19, 32.8, and RCP.

5.1.4 Subsurface Soils

Analysis of the subsurface soils indicates that organic and inorganic compounds exist above the method detection limits at the WWTF. The most commonly detected VOCs were acetone, methylene chloride, PCE, and toluene. The most commonly detected SVOCs were bis(2-ethylhexyl)phthalate, pentachlorophenol, and phenol. The metals analysis indicates that arsenic, barium, and selenium were commonly found at high concentrations. Appendix G is an analysis of the data showing the average, maximum, and minimum concentration of the above compounds for each SWMU.

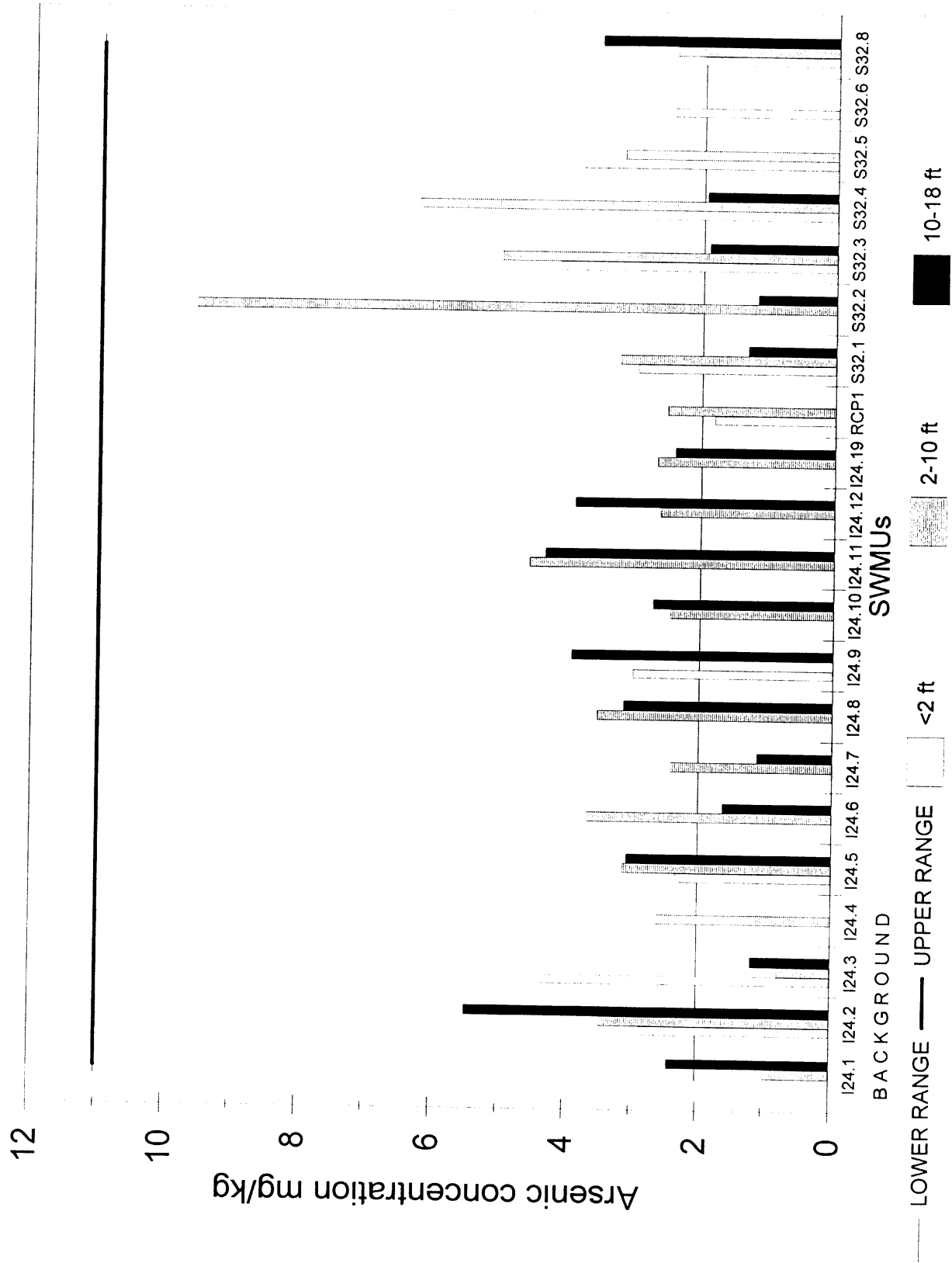


FIGURE 5.8
AVERAGE ARSENIC
CONCENTRATION IN
SOIL SAMPLES

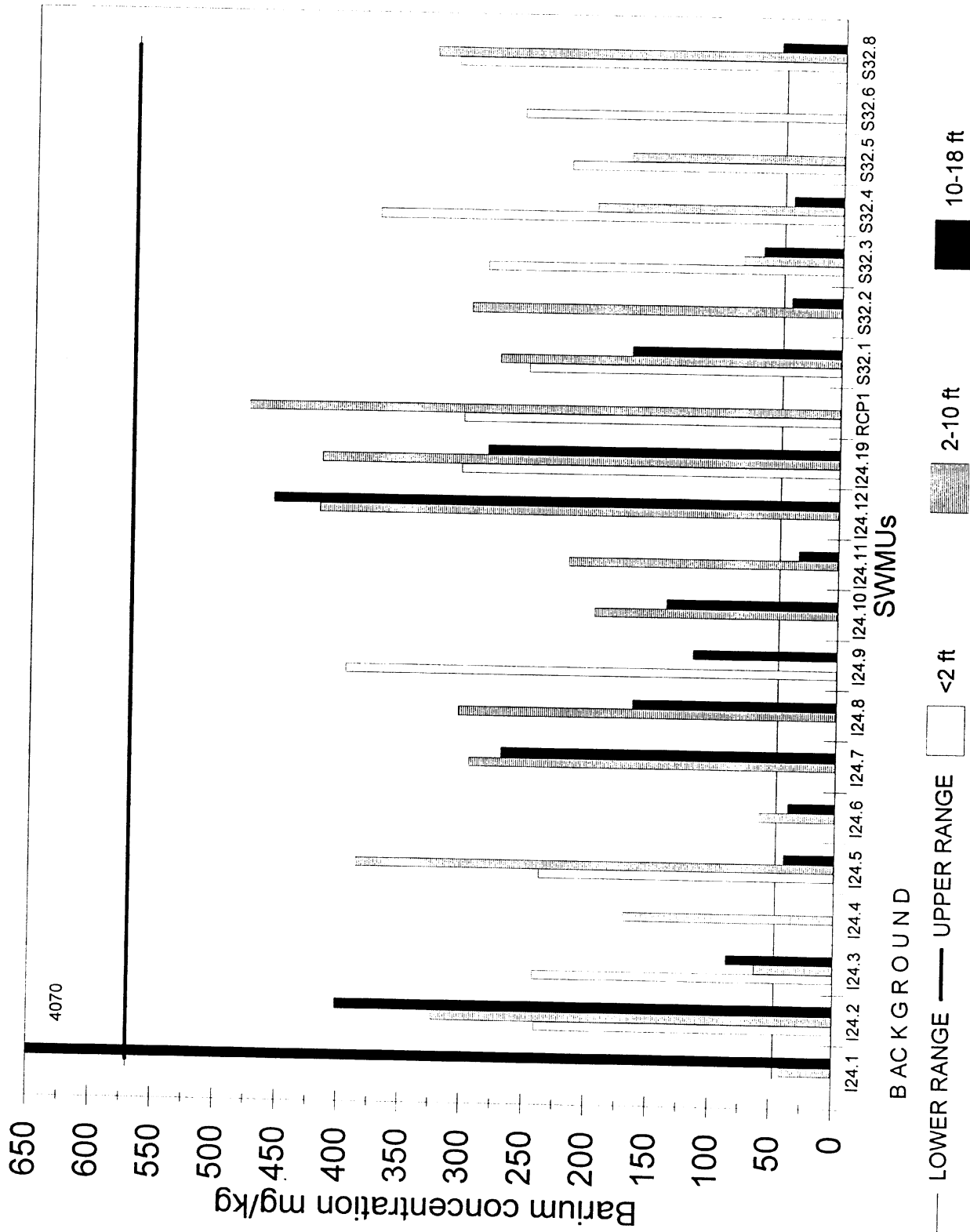


FIGURE 5.9
AVERAGE BARIUM
CONCENTRATION IN
SOIL SAMPLES

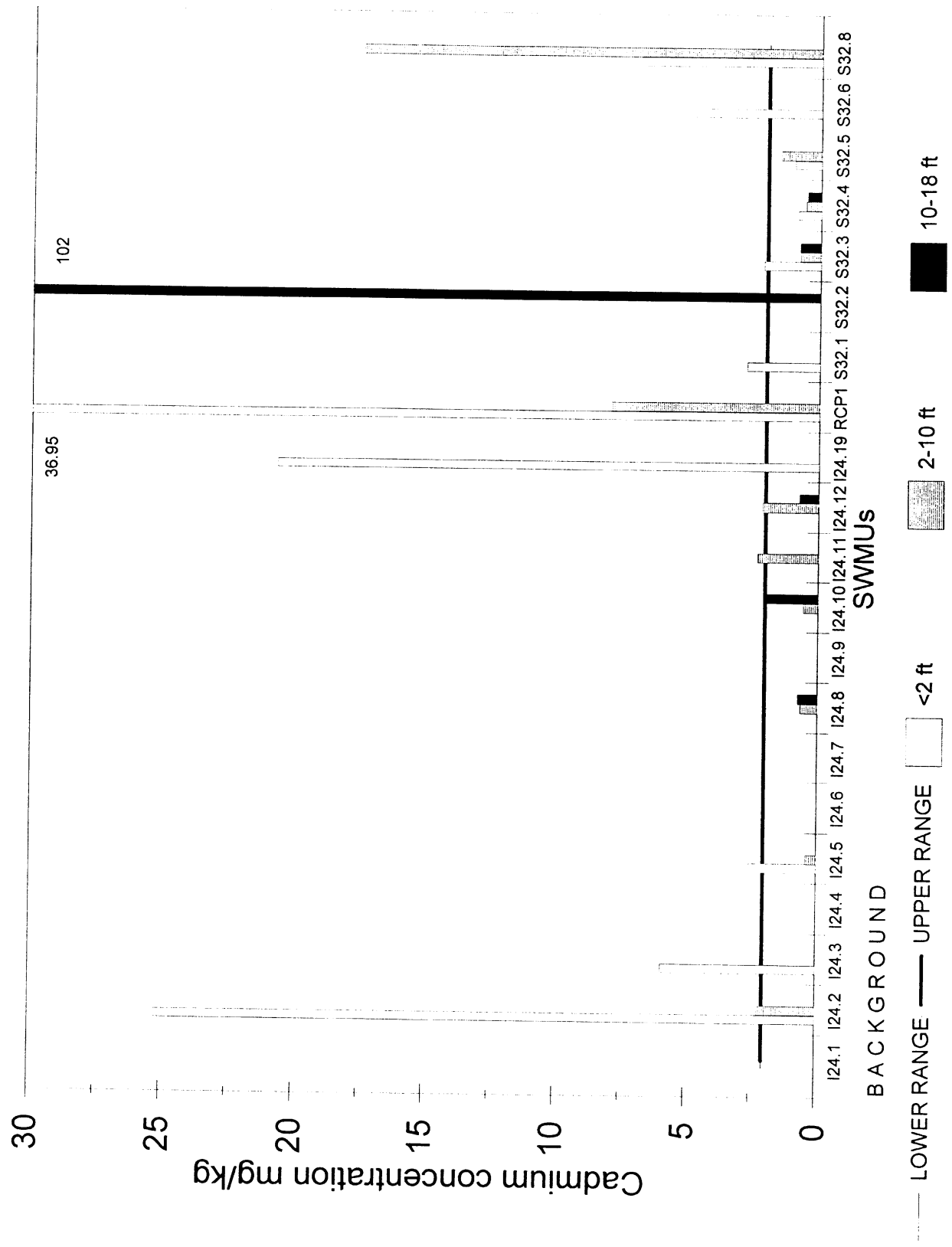


FIGURE 5.10
AVERAGE CADMIUM
CONCENTRATION IN
SOIL SAMPLES

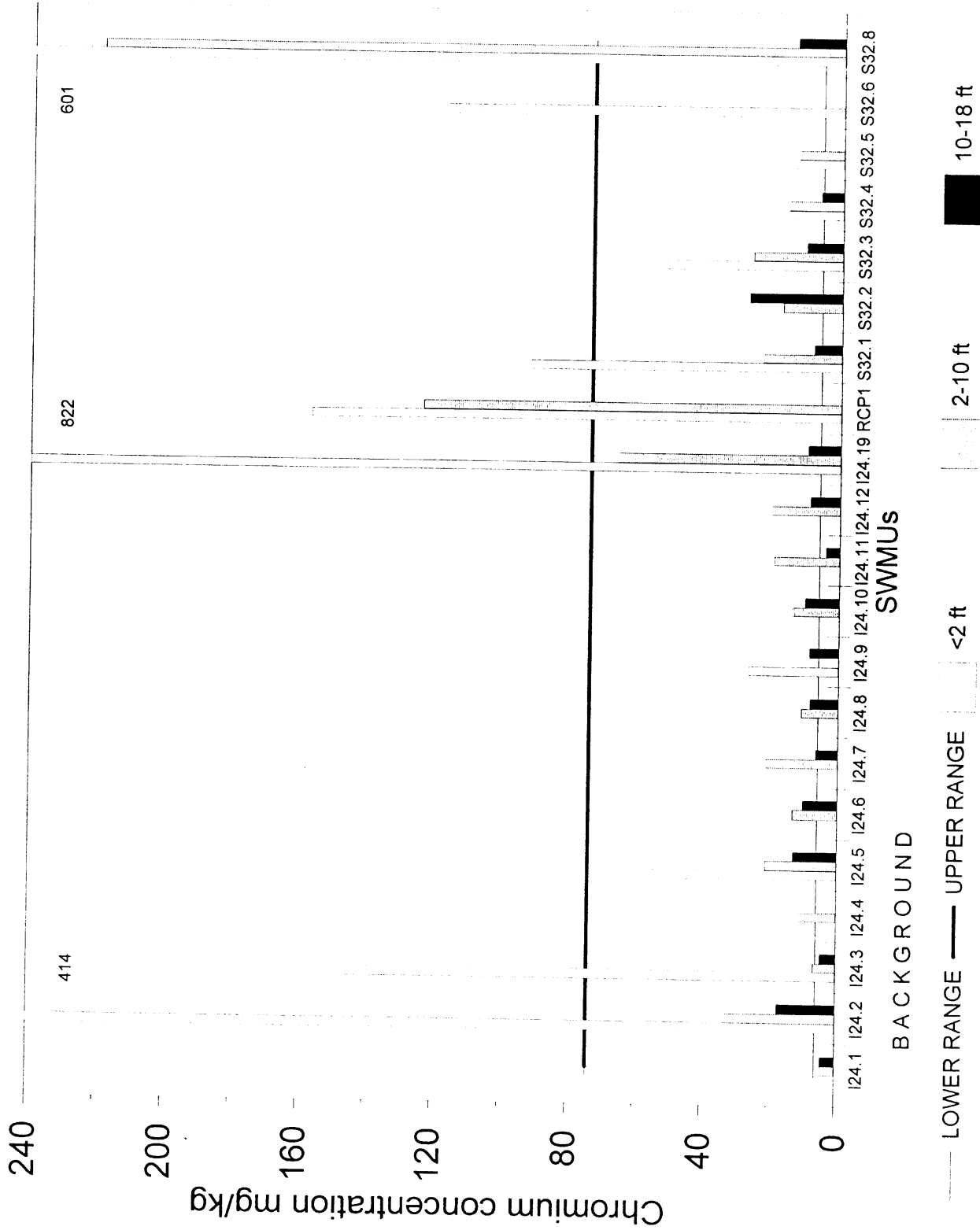


FIGURE 5.11

AVERAGE CHROMIUM
CONCENTRATION IN
SOIL SAMPLES

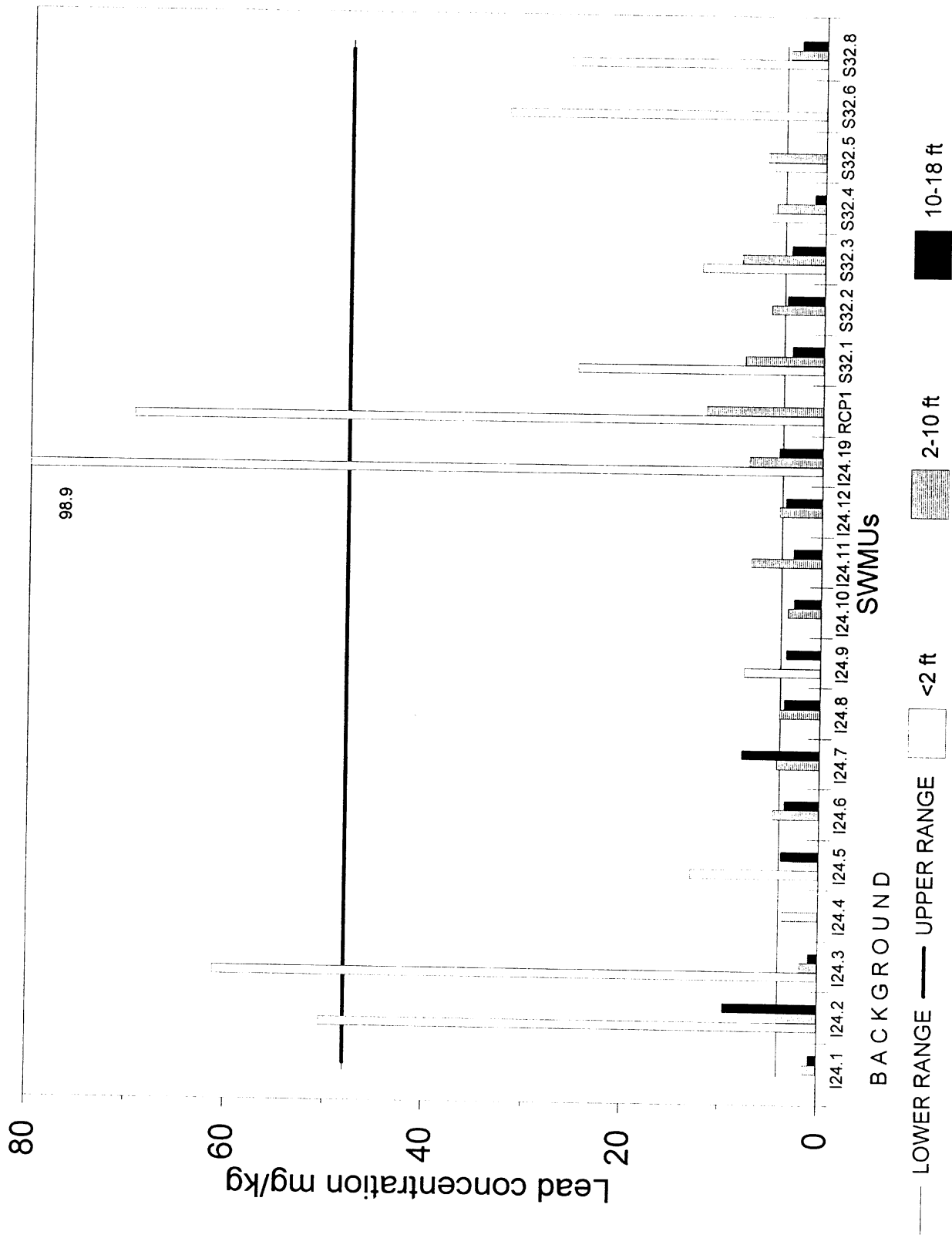


FIGURE 5.12
AVERAGE LEAD
CONCENTRATION IN
SOIL SAMPLES

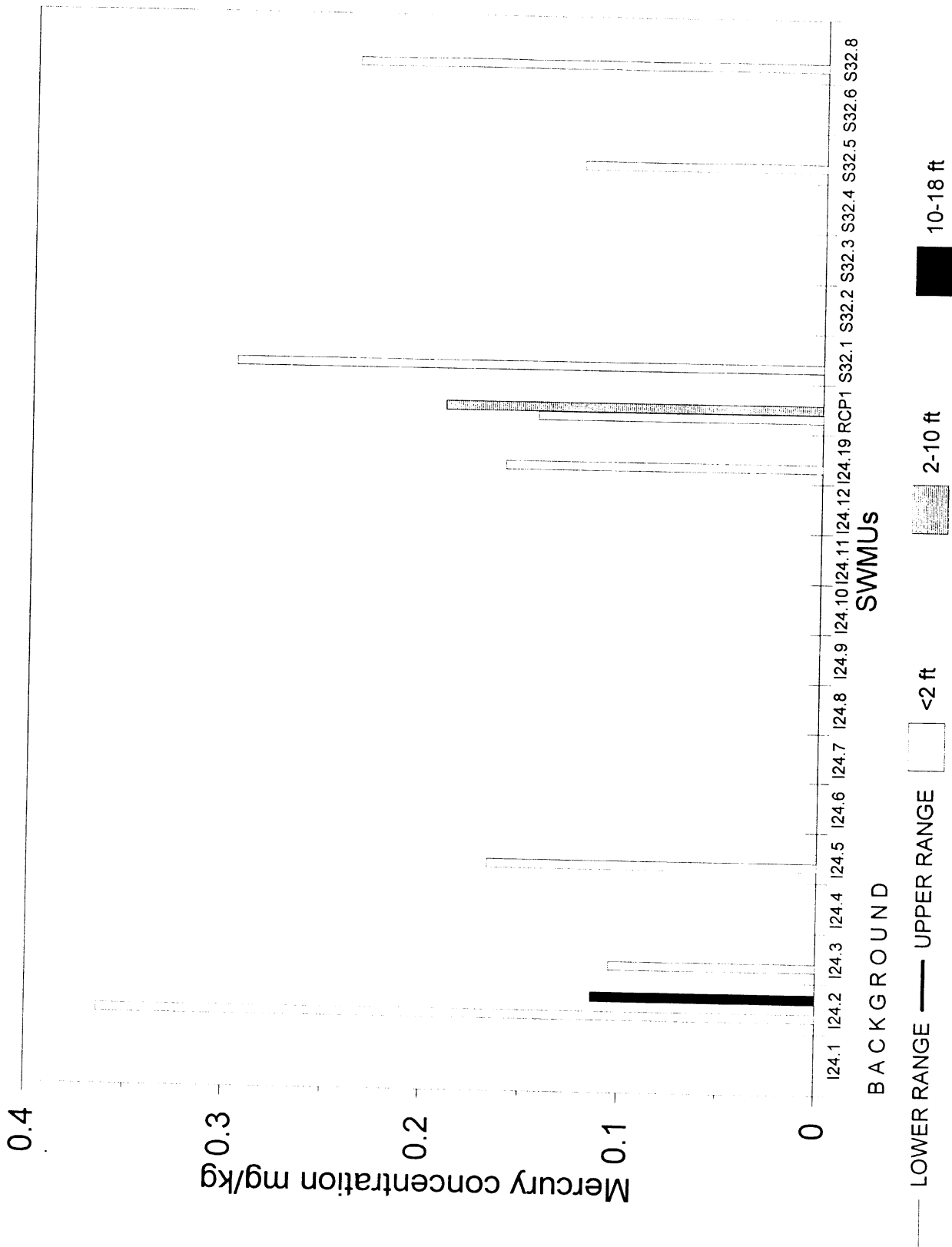


FIGURE 5.13
AVERAGE MERCURY
CONCENTRATION IN
SOIL SAMPLES

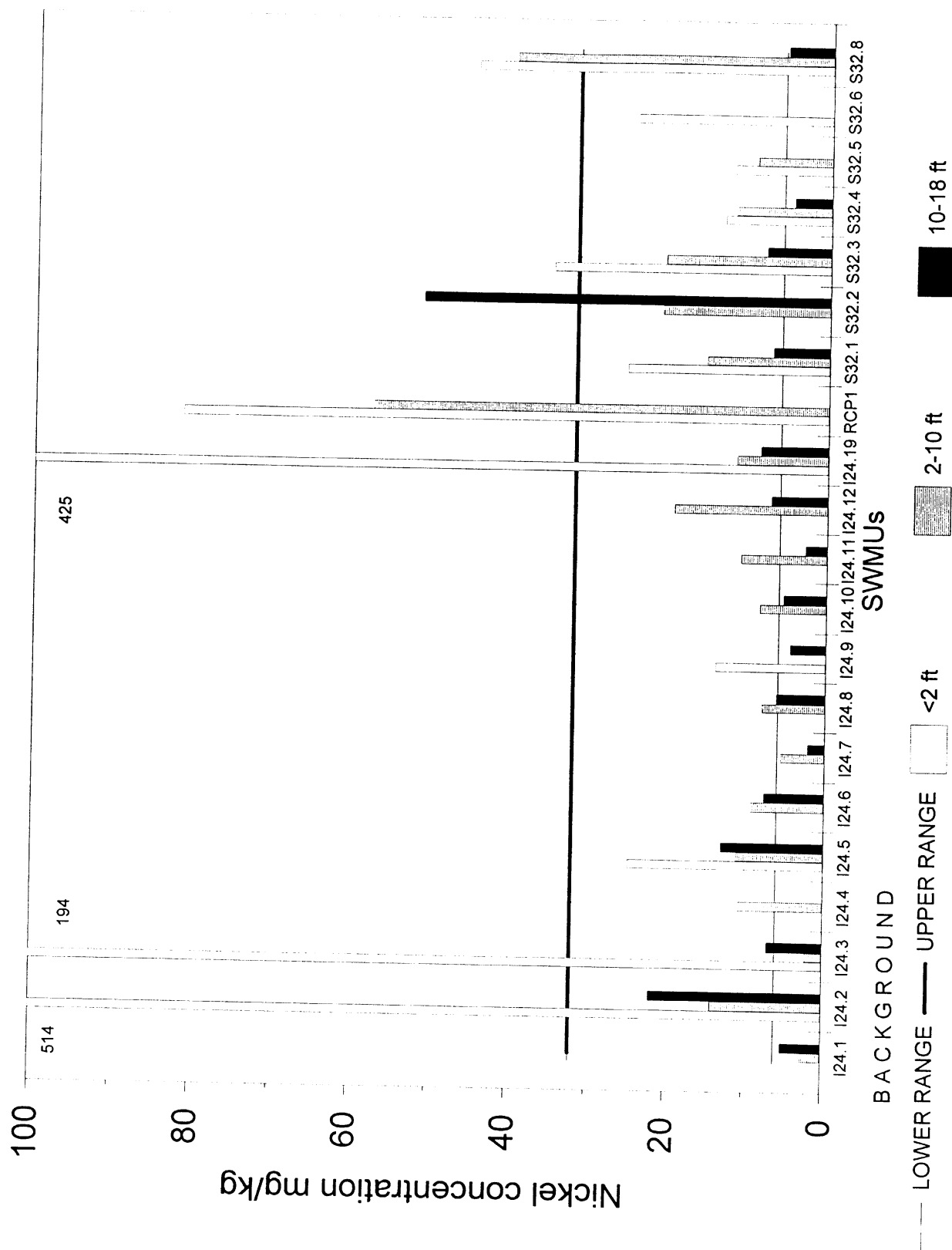


FIGURE 5.14
AVERAGE NICKEL
CONCENTRATION IN
SOIL SAMPLES

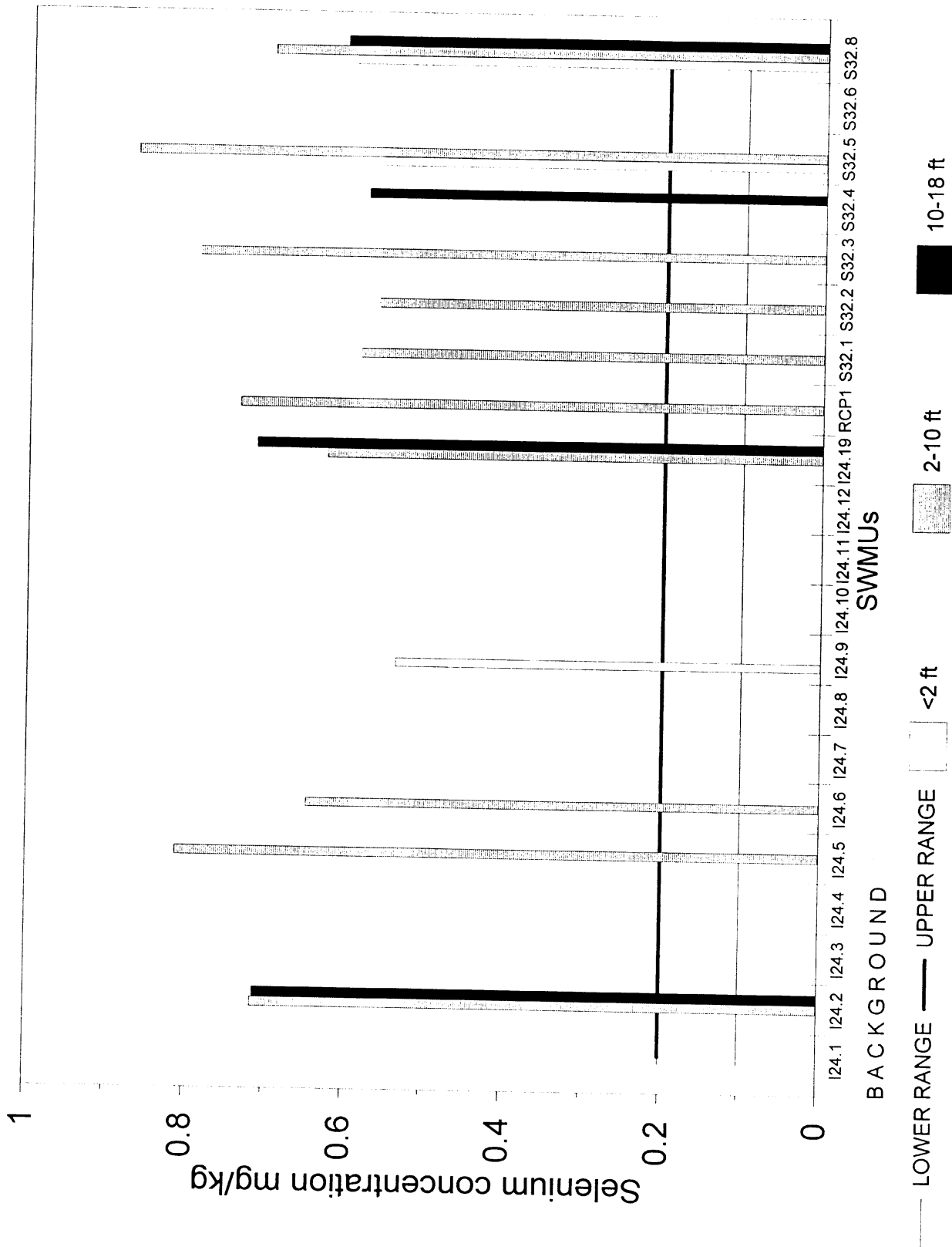


FIGURE 5.15
AVERAGE SELENIUM
CONCENTRATION IN
SOIL SAMPLES

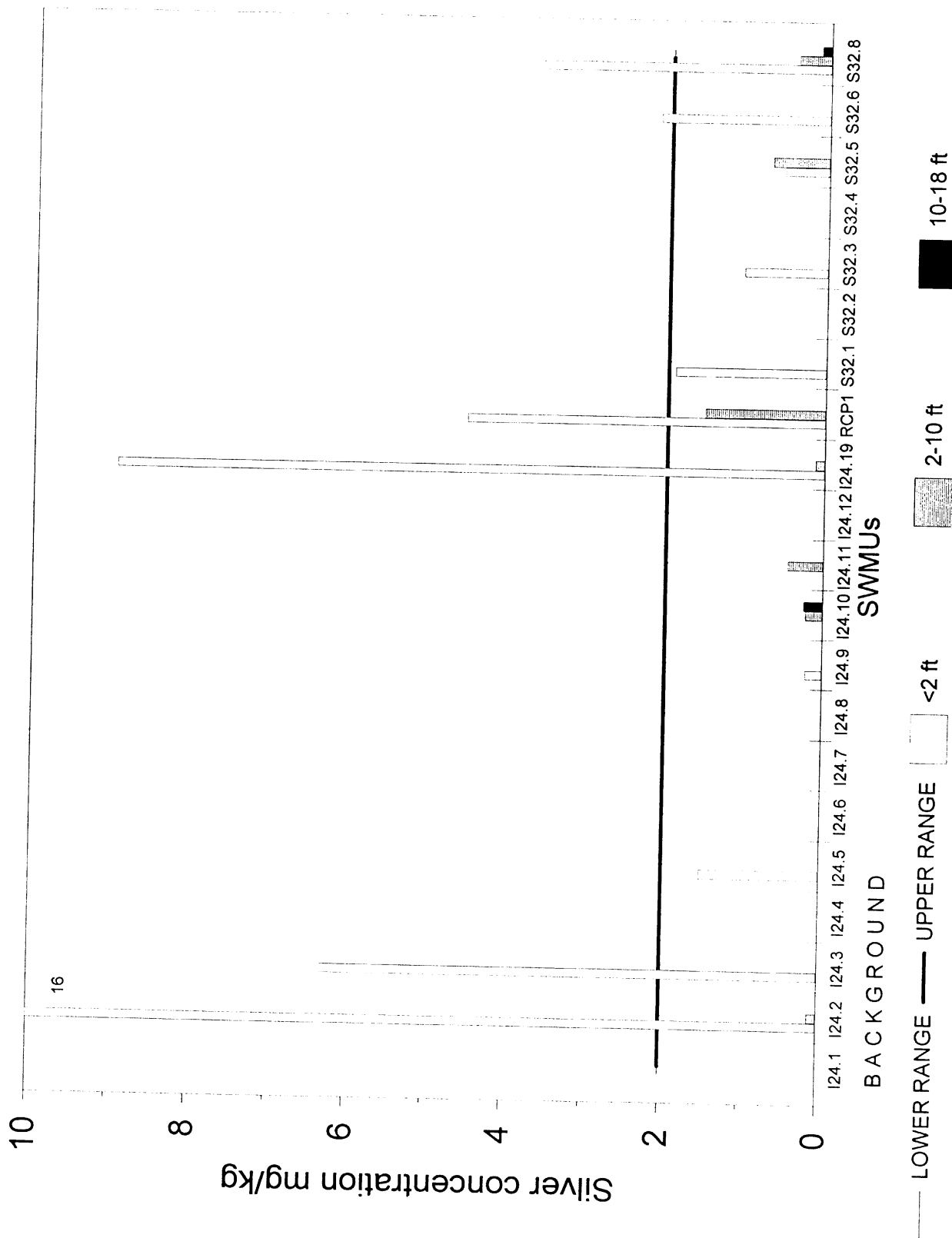


FIGURE 5.16
AVERAGE SILVER
CONCENTRATION IN
SOIL SAMPLES

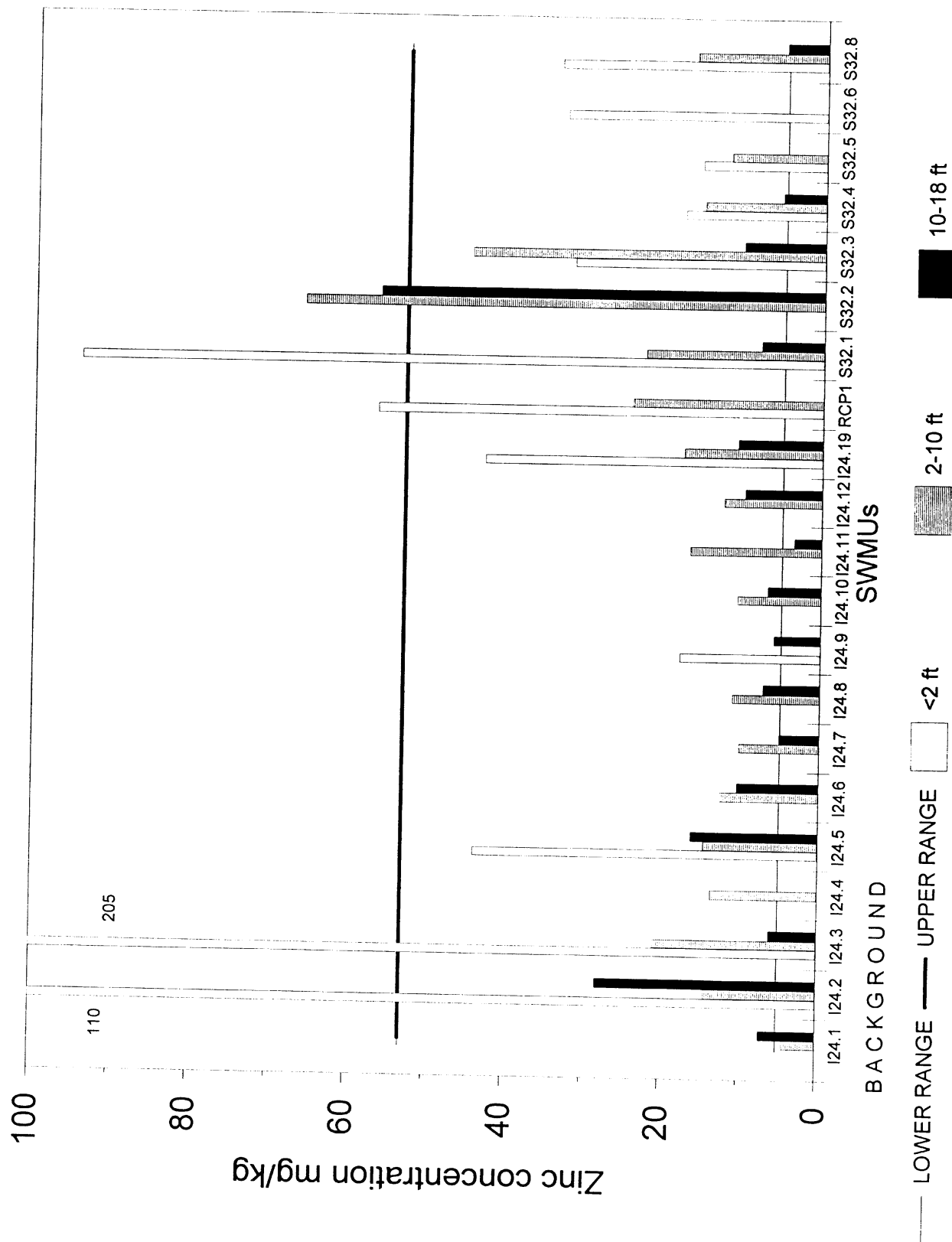


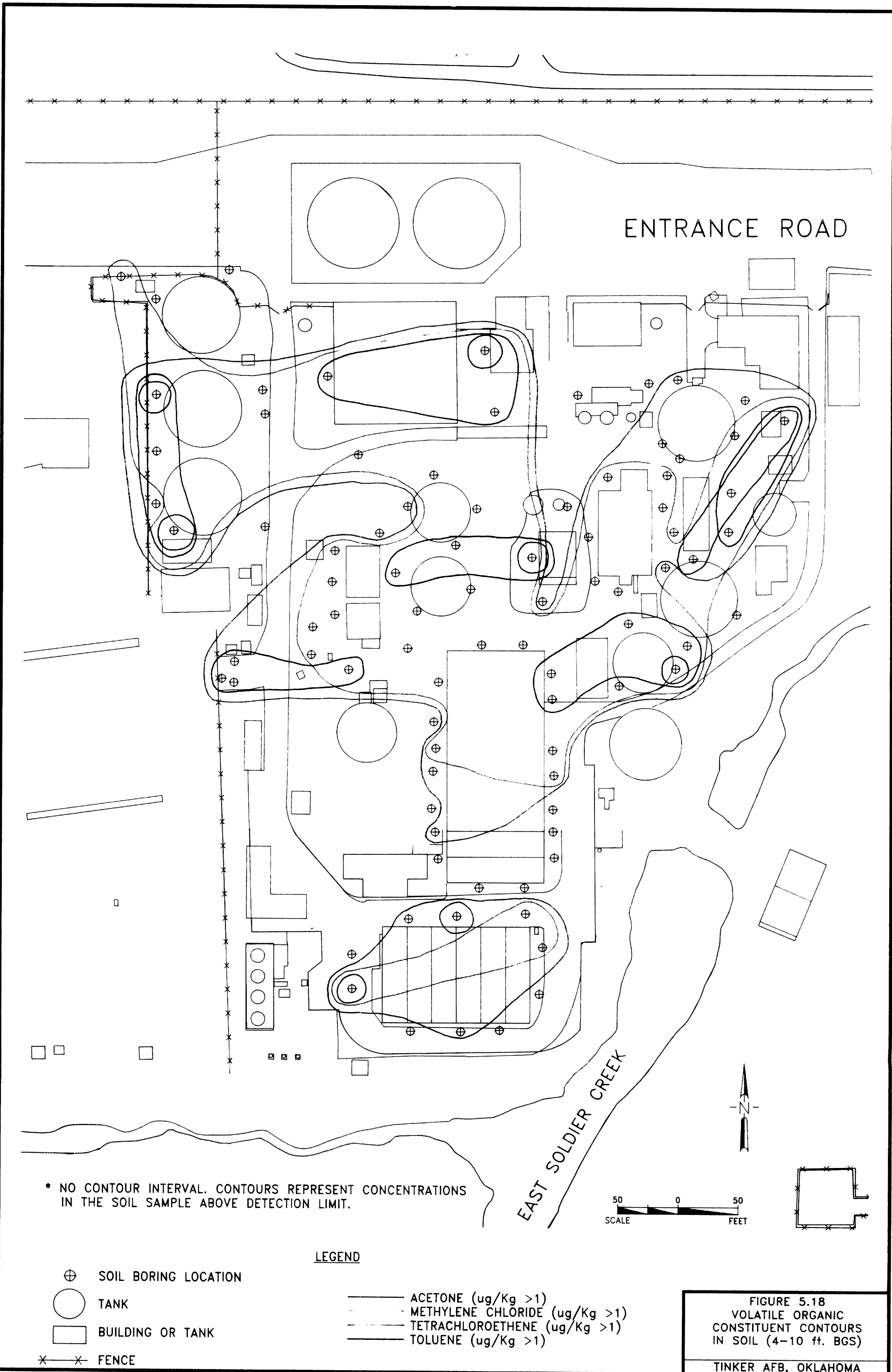
FIGURE 5.17
AVERAGE ZINC
CONCENTRATION IN
SOIL SAMPLES

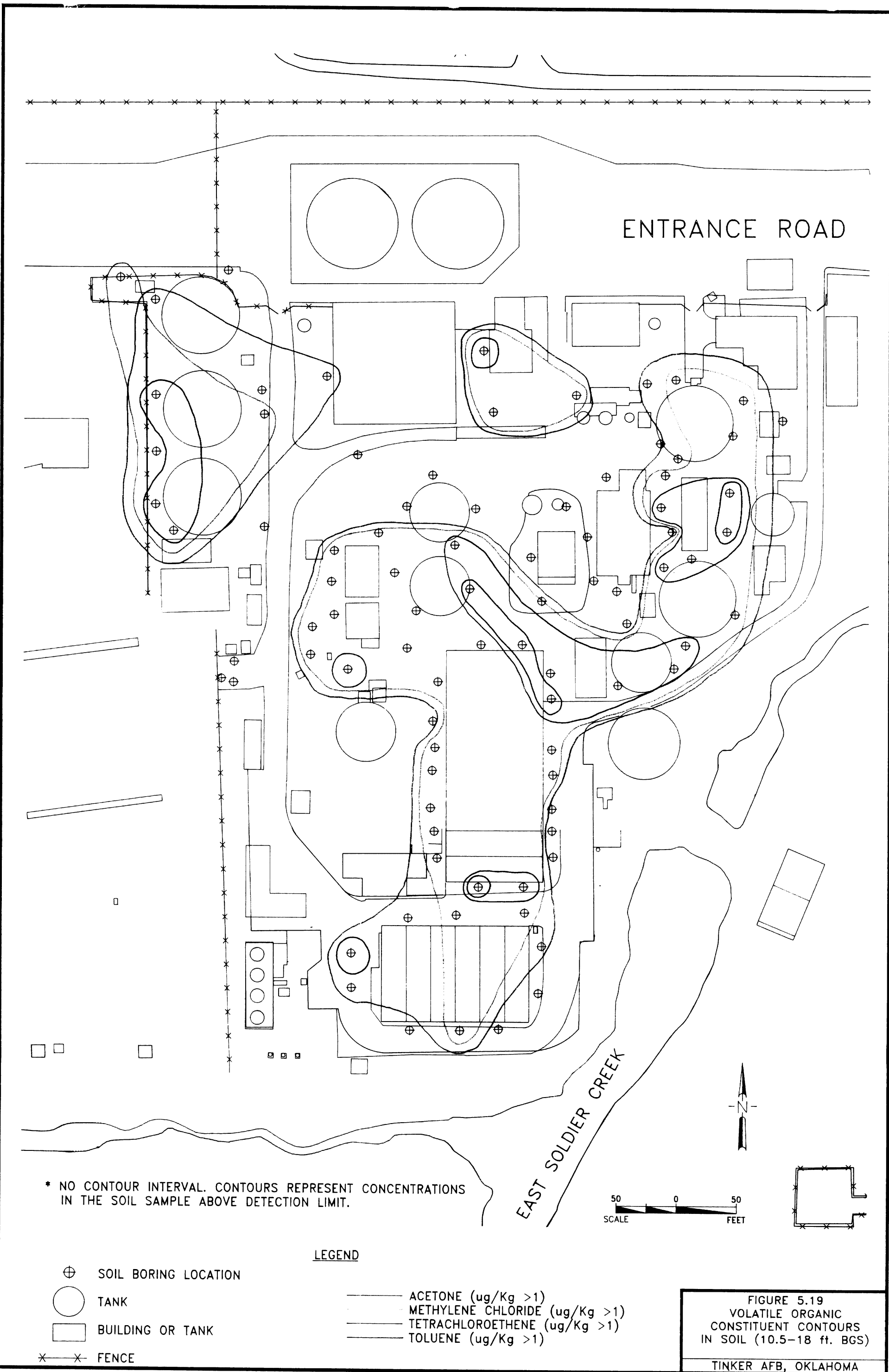
Figures 5.18 through 5.21 show the general borehole locations in which the above described organics were found at concentrations exceeding the detection limit. The samples from the soil borings were generally collected from an upper horizon ranging from 4 to 10 feet bgs and a lower horizon ranging from 10.5 to 18 feet bgs. Figures 5.18 and 5.20 represent contamination found in the upper horizon, and Figures 5.19 and 5.21 represent contamination found in the lower horizon.

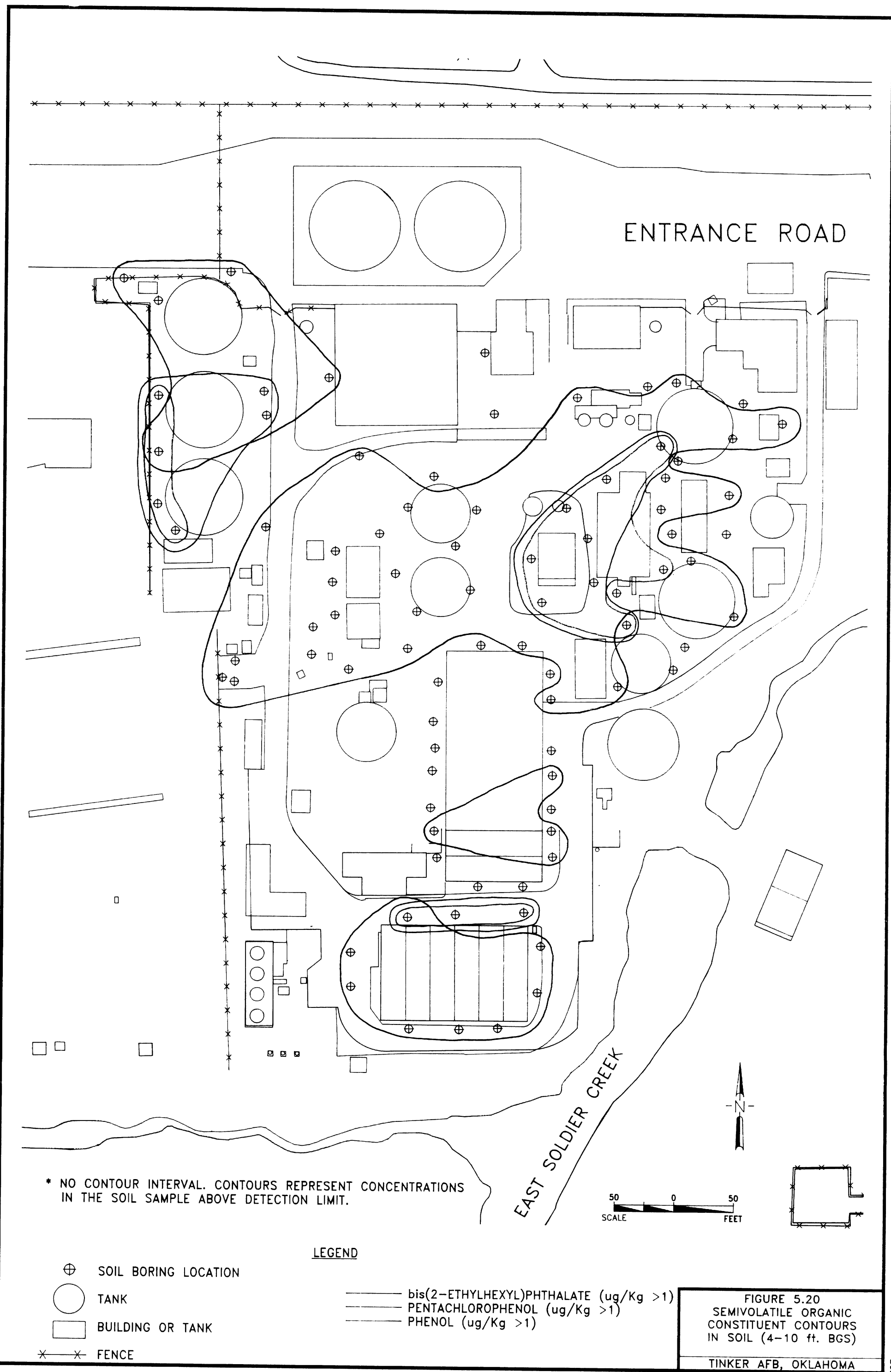
Figures 5.22 through 5.27 show cross sections through several areas of the WWTF and the major contaminants found in samples collected throughout the soil borings. Figure 5.1 shows locations of the cross sections. As discussed below, the evidence of releases were present throughout the soil columns.

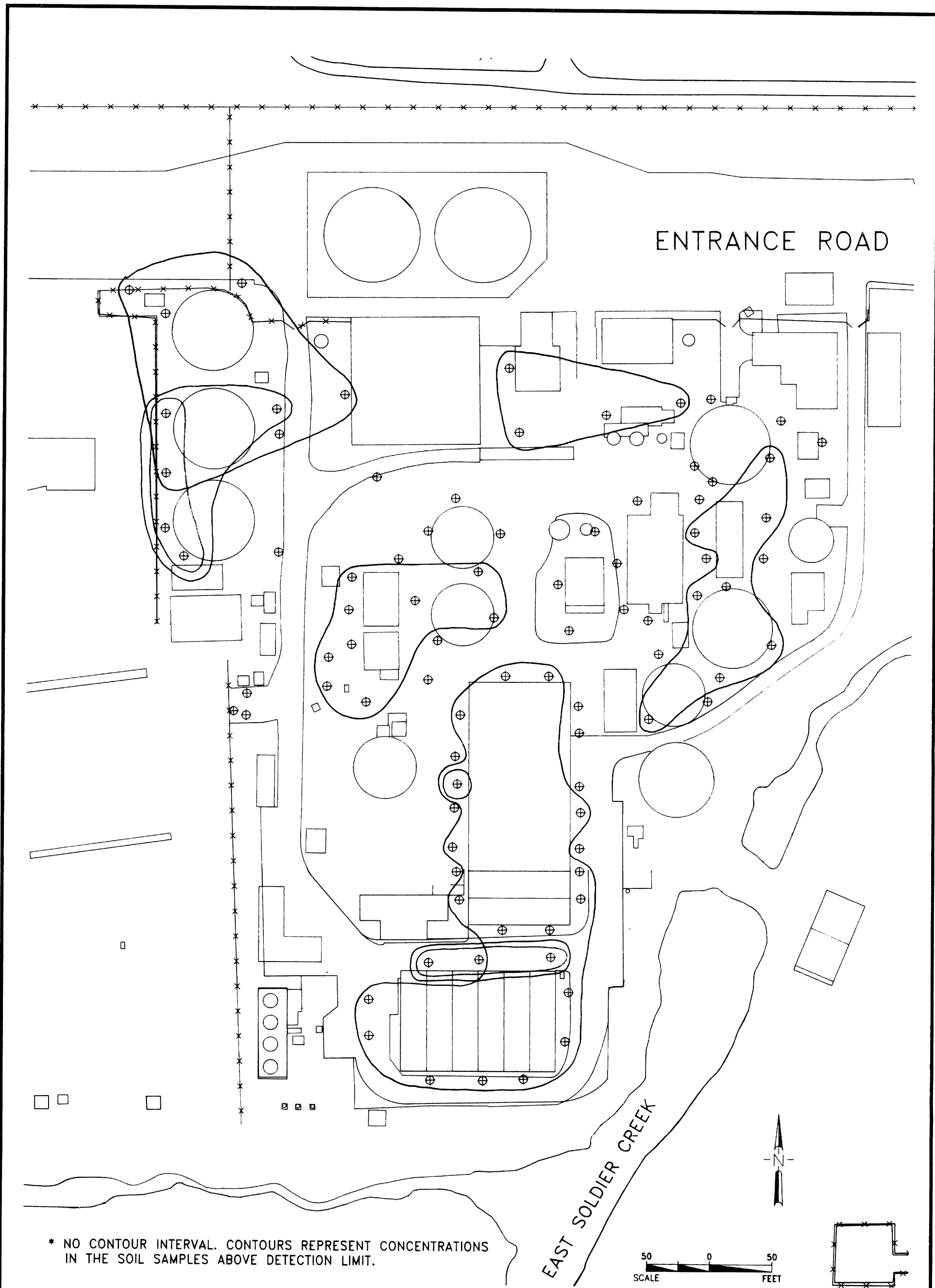
Acetone is the most predominant VOC contaminant found in the soil boring samples. Figure 5.18 shows that all of the SWMUs exhibit acetone contamination along the A-A' profile in the 4- to 10-foot-bgs range except 24.1, 24.2, and 32.6. Figure 5.19 shows that all of the SWMUs exhibit acetone contamination in the 10.5- to 18-foot-bgs range except 24.1. It should be noted that samples from 32.5 and 32.6 were collected only at shallow depths because of the high water table conditions at those two units. The highest acetone concentrations in the lower horizon range from 1,100 $\mu\text{g}/\text{kg}$ at SWMUs 32.3 and 32.8 to 28 $\mu\text{g}/\text{kg}$ at 24.5. Generally, the concentrations tend to be greater in the shallow horizon than the deep horizon. The highest concentration of acetone in the upper horizon ranges from 4,200 $\mu\text{g}/\text{kg}$ at SWMU 24.4 to 26 $\mu\text{g}/\text{kg}$ at SWMU 24.6. Acetone was detected in some of the QA/QC samples associated with the soil samples, including trip blanks and laboratory method blanks. A complete discussion of blank contamination is in the soil and water sample QA/QC report (appendix J). The sample results possibly affected by blank contamination are flagged as estimated in section 4. The data may include results with false detections or high bias; however, acetone was also detected in the influent wastewater samples. Therefore, the presence of acetone in the soil samples cannot be entirely attributed to laboratory contamination. Acetone was not detected in the ambient condition blanks.

All of the SWMUs except 24.3, 24.7, and 32.6 exhibit methylene chloride contamination at depths ranging from 4 to 10 feet bgs. All of the SWMUs except 24.3 and 24.4 exhibit methylene chloride contamination at depths ranging from 10.5 to 18 feet bgs. Samples were not recovered below 10 feet BGL at SWMUs 32.5 and 32.6. Generally, the concentrations tend to be greater in the shallow horizon than the deep horizon. The highest concentration of methylene chloride in the upper horizon ranges from 80 $\mu\text{g}/\text{L}$ at SWMU 24.2 to 10 $\mu\text{g}/\text{L}$ at SWMU 24.6. The highest concentration in the lower horizon ranges from 56 $\mu\text{g}/\text{kg}$ at SWMU 32.8 to 4.4 $\mu\text{g}/\text{kg}$ at SWMU 24.11. Methylene chloride was not detected in the ambient condition blanks, indicating the soil and water samples were not contaminated during sampling. Methylene chloride was detected in some of the QA/QC samples associated with the samples, including trip blanks and laboratory method blanks. A complete discussion of blank contamination is in the soil and water sample QA/QC report (appendix J). The results presented in section 4 have been flagged as estimated concentrations. The laboratory contamination may have resulted in









* NO CONTOUR INTERVAL. CONTOURS REPRESENT CONCENTRATIONS IN THE SOIL SAMPLES ABOVE DETECTION LIMIT.

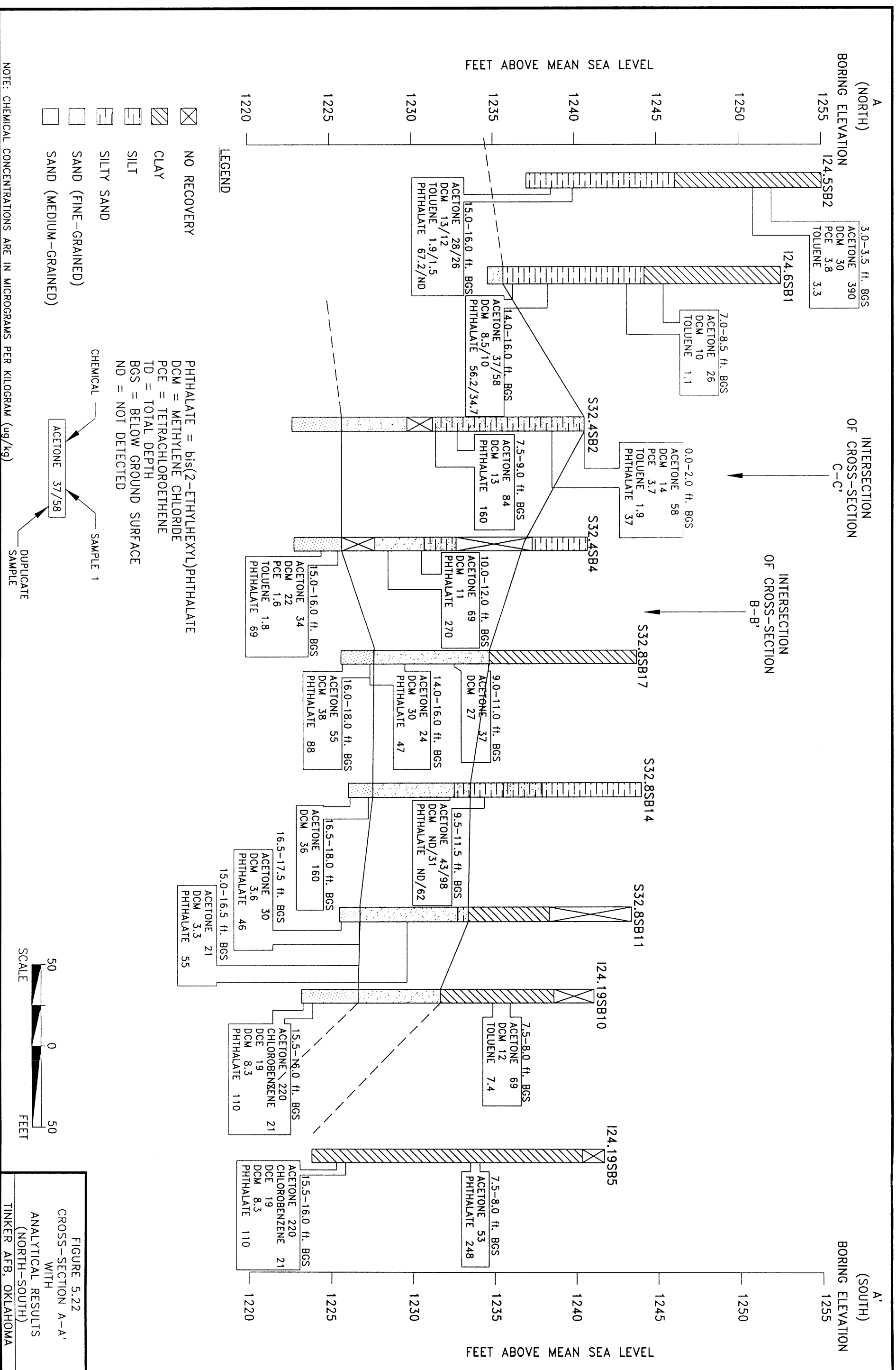
LEGEND

- ⊕ SOIL BORING LOCATION
- TANK
- BUILDING OR TANK
- ×—× FENCE

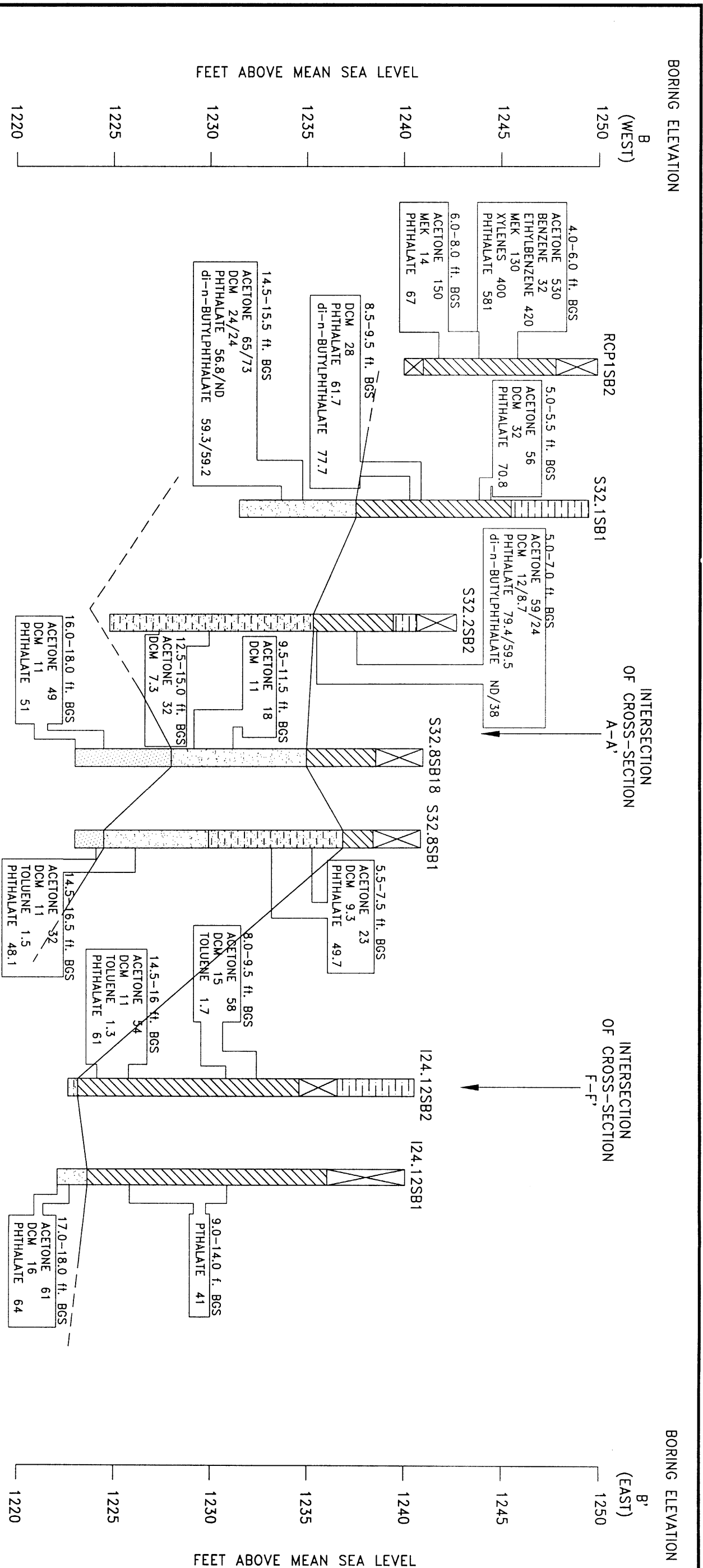
- bis(2-ETHYLHEXYL)PHTHALATE (ug/Kg >1)
- PENTACHLOROPHENOL (ug/Kg >1)
- PHENOL (ug/Kg >1)

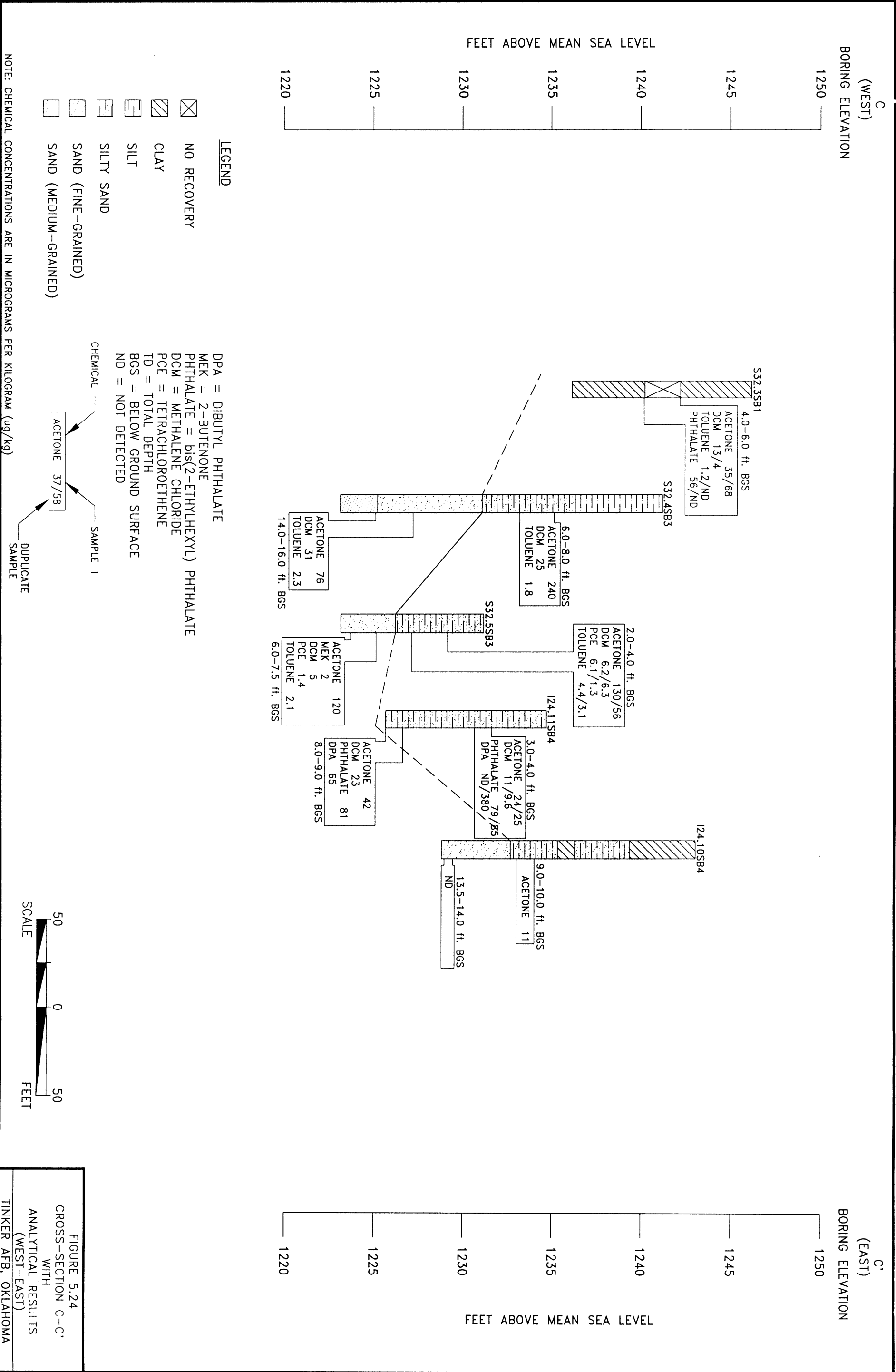
FIGURE 5.21
SEMIVOLATILE ORGANIC
CONSTITUENT CONTOURS
IN SOIL (10.5-18 ft. BGS)

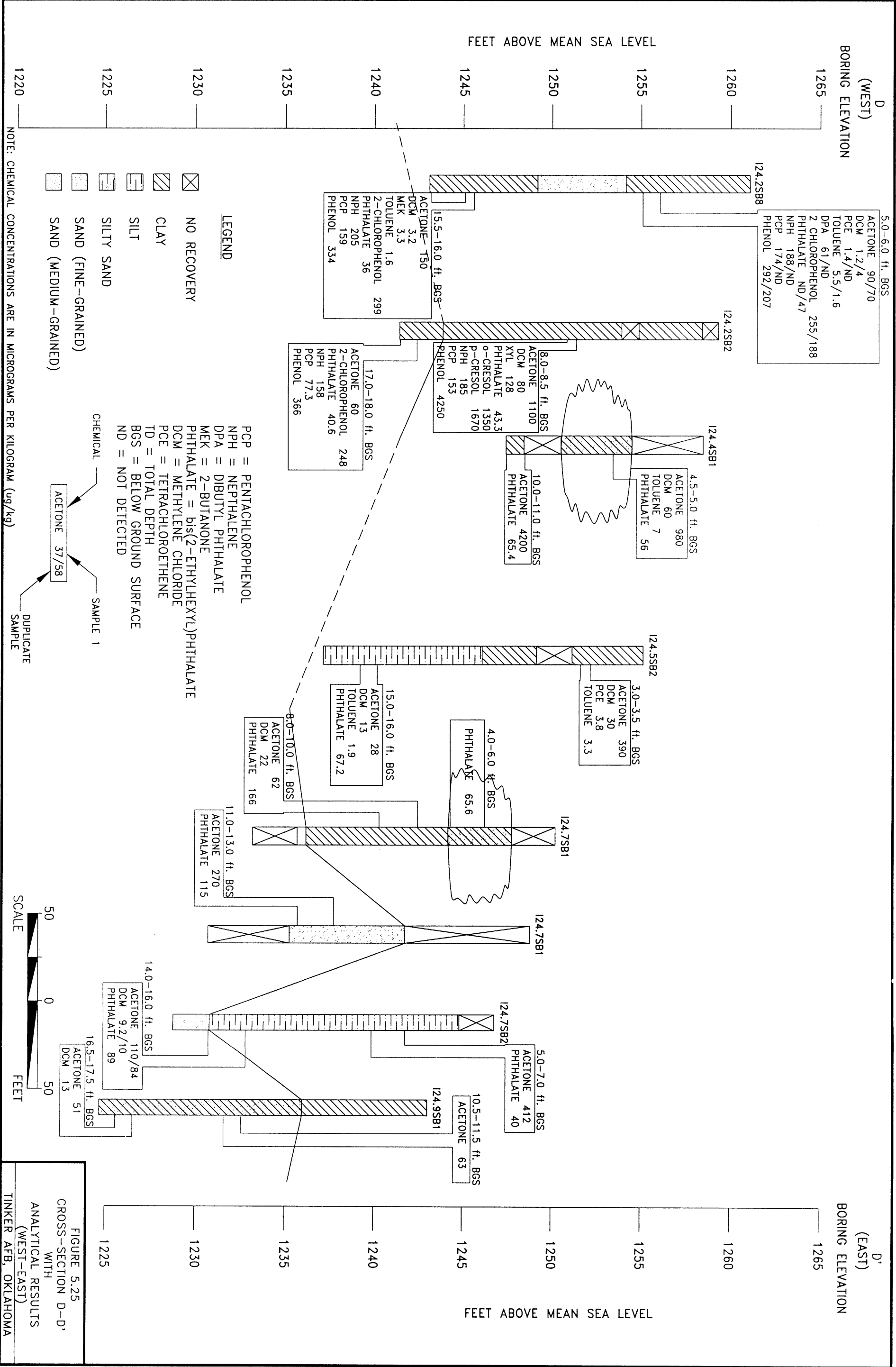
TINKER AFB, OKLAHOMA

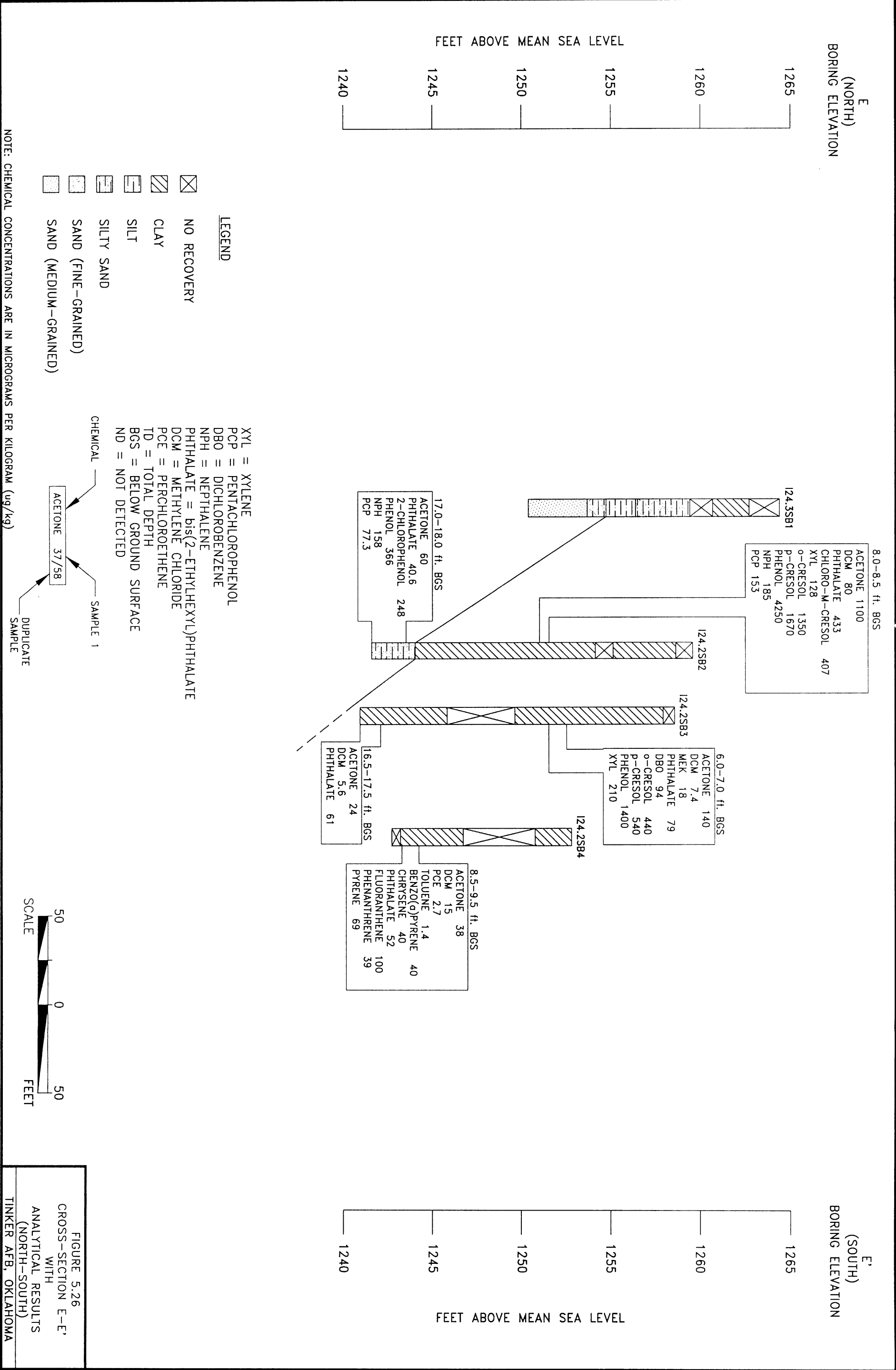


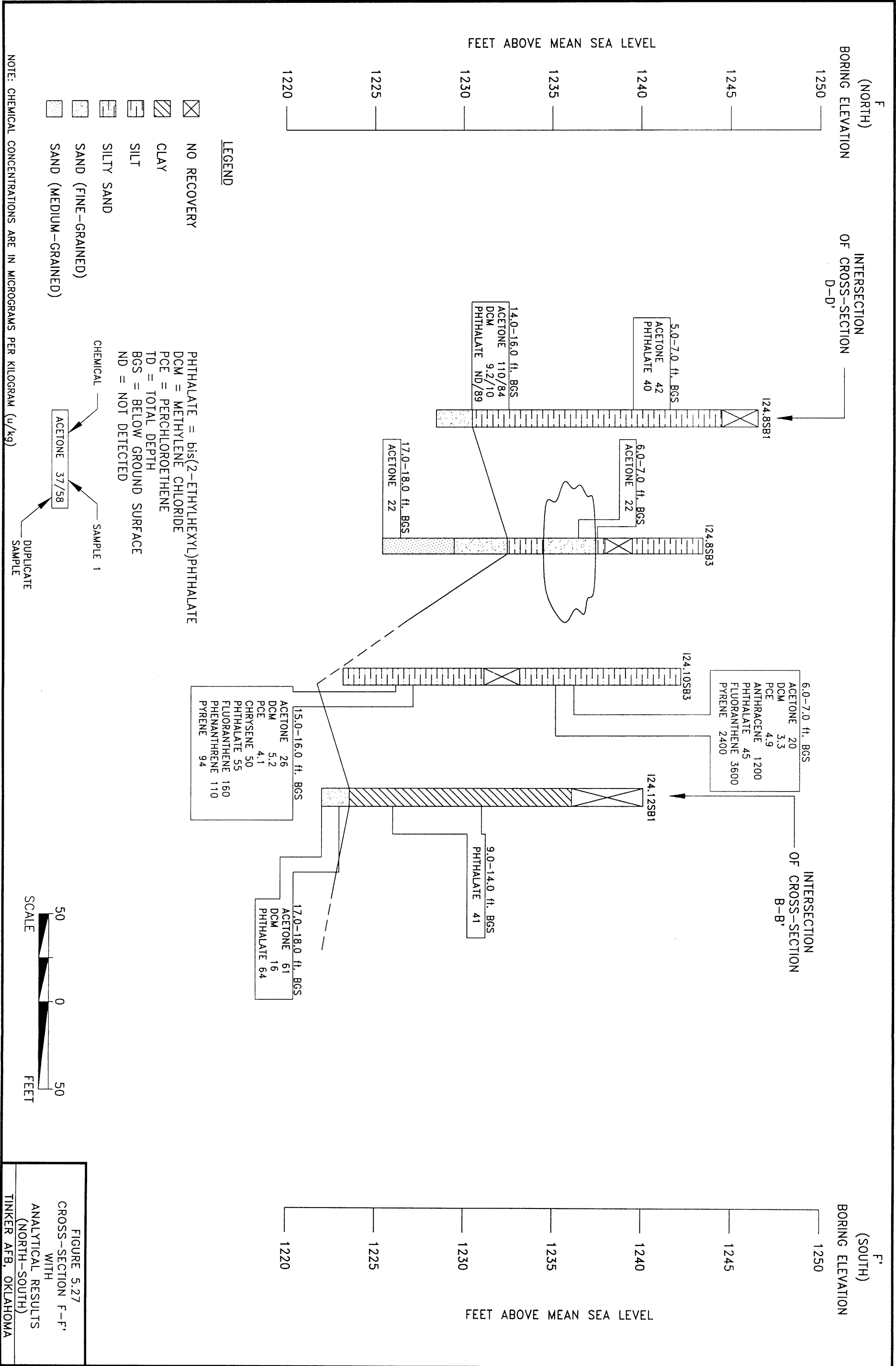
TRFI-XS2 1/8/94











samples with false detections or high bias; however, methylene chloride was also detected in the influent wastewater samples. Therefore, the presence of methylene chloride in the soil samples cannot be entirely attributed to the laboratory contamination.

SWMUs 24.2, 24.5, 24.9, 24.10, 24.12, 24.19, and 32.5 exhibit PCE contamination at depths ranging from 4 to 10 feet bgs. SWMUs 24.10, 24.11, 24.12, 24.19, 32.4, and 32.8 exhibit PCE contamination at depths ranging from 10.5 to 18 feet bgs. Generally, the concentrations tend to be greater in the shallow horizon than the deep horizon. The highest concentration of PCE in the upper horizon ranges from 68 $\mu\text{g/kg}$ at SWMU 24.18 to 1.4 $\mu\text{g/kg}$ at SWMU 32.5. The highest concentration in the lower horizon ranges from 6.2 $\mu\text{g/kg}$ at SWMU 24.19 to 1.3 $\mu\text{g/kg}$ at SWMU 24.12.

SWMUs 24.2, 24.4, 24.5, 24.6, 24.9, 24.10, 24.12, 24.19, 32.1, 32.4, 32.5, and 32.8 and the recirculation pit exhibit toluene contamination at depths ranging from 4 to 10 feet bgs. SWMUs 24.2, 24.5, 24.10, 24.12, 24.19, 32.1, 32.4, and 32.8 exhibit toluene contamination at depths ranging from 10.5 to 18 feet bgs. Generally, the concentrations tend to be greater in the shallow horizon than the deep horizon. The highest concentration of toluene in the upper horizon ranges from 1,200 $\mu\text{g/kg}$ at RCP to 1.1 $\mu\text{g/kg}$ at SWMU 24.6. The highest concentration in the lower horizon ranges from 4.6 $\mu\text{g/kg}$ at SWMU 32.8 to 1.4 $\mu\text{g/kg}$ at SWMU 32.1.

Of the SVOCs analyzed from the soil boring samples, bis(2-ethylhexyl)phthalate is the most commonly occurring. Figures 5.20 and 5.21 show that this compound occurs in all but a few of the samples.

All of the SWMUs, except 24.6 in the upper horizon and 24.9 in the lower horizon, exhibit bis(2-ethylhexyl)phthalate contamination. Samples were not recovered below 10 feet bgs at SWMUs 32.5 and 32.6. Generally, the concentrations tend to be greater in the upper horizon than the lower horizon. The highest concentration of bis(2-ethylhexyl)phthalate in the upper horizon ranges from 2,130 $\mu\text{g/kg}$ at RCP to 64 $\mu\text{g/kg}$ at SWMU 24.8. The highest concentration in the lower horizon ranges from 265 $\mu\text{g/kg}$ at SWMU 32.1 to 55 $\mu\text{g/kg}$ at SWMU 24.10. Bis(2-ethylhexyl)phthalate was detected in some of the laboratory blanks; additionally, some samples results were reported at concentrations below the MDL (90.1 mg/kg). Therefore, some of the results may include false positives or have a high bias.

SWMUs 24.2, 24.8, 24.11, 24.12, 24.19, 32.5, and 32.6 and the recirculation pit exhibit pentachlorophenol contamination at depths ranging from 4 to 10 feet bgs. SWMUs 24.2 and 24.19 exhibit pentachlorophenol contamination at depths ranging from 10.5 to 18 feet bgs. The highest concentration of pentachlorophenol in the upper horizon ranges from 472 $\mu\text{g/kg}$ at SWMU 24.2 to 120 $\mu\text{g/kg}$ at RCP. The highest concentration in the lower horizon ranges from 233 $\mu\text{g/kg}$ at SWMU 24.19 to 178 $\mu\text{g/kg}$ at SWMU 24.2.

SWMUs 24.2, 24.8, 24.11, 24.12, and 24.19 and the RCP exhibit phenol contamination at depths ranging from 4 to 10 feet bgs. SWMUs 24.2 and 24.19 exhibit phenol contamination at depths ranging from 10.5 to 18 feet bgs. Generally,

the concentrations tend to be greater in the upper horizon than the lower horizon. The highest concentration of phenol in the upper horizon ranges from 4,210 $\mu\text{g}/\text{kg}$ at SWMU 24.2 to 310 $\mu\text{g}/\text{kg}$ at SWMU 24.11. The highest concentration in the lower horizon ranges from 375 $\mu\text{g}/\text{kg}$ at SWMU 24.2 to 205 $\mu\text{g}/\text{kg}$ at SWMU 32.8.

Figures 5.8 through 5.17 show the SWMU-average metal concentration for the subsurface soils for the shallow horizon 2-10 feet bgs, and for the deep horizon 10-18 feet bgs. Selenium (Figure 5.15) was found at several SWMUs above average background concentrations. The soils at the recirculation pit contained elevated levels of nickel, mercury, chromium, and cadmium. SWMUs 24.2 and 32.8 also contained high levels of cadmium, chromium, and mercury. Barium concentrations in the soils from 2-10 feet bgs were higher than average background levels at nearly every SWMU (Figure 5.9).

5.2 AIR

5.2.1 VOCs

Table 5.2 summarizes the number of detections and range of concentrations observed for the SUMMA canister sampling.

Source: Several compounds (acetone, 1,1,1-trichloroethane, dichloromethane and tetrachloroethene, and toluene) appeared in almost all of the flux chamber samples at concentrations significantly higher than other compounds. Several other compounds were detected often but not always (1,1-DCA, benzene, ethylbenzene, MEK, trichloroethene, trichlorotrifluoroethane [F-113], xylenes, and some of the chlorinated benzenes). Typically, concentrations of these compounds decreased from the beginning of the process train to the end, as would be expected for VOCs in aerated or agitated liquid streams. The waste-activated sludge facility showed some emission of VOCs, but the frequency and concentrations were not high enough to warrant sampling during Phase B. The field GC showed fuel-like chromatograms on several samples taken from the oil separator.

Process and Ambient: Several compounds including the chlorinated benzenes were nearly always detected in source emissions, but were not found in either process or ambient samples, or were detected infrequently. These compounds are among the least volatile of the VOCs and are probably better represented by the SVOC data. In general terms, most compounds detected in source emissions appeared in the process and ambient samples at lower frequencies and reduced concentrations. One notable exception is acetone, which appeared in all three types of samples at about the same frequency and concentration, indicating sources other than the IWTP, as the QC data validate the acetone data. Several other compounds were found in source emissions some of the time, but rarely in the process or ambient samples, including F-113, cis-1,2-DCE, TCE, and ethylbenzene.

5.2.2 Field GC

The field GC results of the flux chamber bag samples are generally consistent with the SUMMA canister results for the same sample. Several compounds were listed as tentatively identified because setup of the column and lack of calibration

Table 5.2
Summary VOC Air Analysis
Tinker AFB, Oklahoma

Analyte	Sampling Location Total Samples			Source 138			Process 206			Ambient 271		
	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$
1,1,1-Trichloroethane (TCA)	126	(91)	2.3-390,000	94	(46)	1.1-190	42	(15)	1-880			
1,1-Dichloroethane	50	(36)	1.7-1,800									
1,1-Dichloroethene	11	(8)	4.8-390									
1,3-Dichlorobenzene	16	(12)	6.2-10,000									
1,4-Dichlorobenzene	56	(41)	1.7-29,000	1	(<1)	24						
2-Butanone (MEK)	50	(36)	3.4-2,200	14	(7)	3.8-27	15	(6)	2.9-36			
2-Hexanone	1	(1)	99									
4-Methyl-2-pentanone (MIBK)	4	(3)	5.3-68				2	(1)	8.4-16			
Acetone	133	(96)	0.6-3,000	189	(92)	5.7-1,700	258	(95)	3.4-2,200			
Benzene	49	(36)	1.1-410	46	(22)	0.6-5.1	65	(24)	0.7-20			
Carbon disulfide	7	(5)	5.8-65	2	(1)	6.4-11	1	(<1)	5.6			
Carbon tetrachloride							1	(<1)	1.3			
Chlorobenzene	22	(16)	2.6-170				1	(<1)	26			
Chloroform	7	(5)	3-480									
Chloromethane (methyl chloride)	4	(3)	7.4-260	2	(1)	1-2.6	4	(1)	1.3-31			
Dichloromethane	126	(91)	13-880,000	167	(81)	5.4-1,500	153	(56)	5-590			
Ethylbenzene	56	(41)	1.1-1,700	6	(3)	2.1-6.9	3	(1)	3.7-8.5			
Styrene	2	(1)	3.6-4.4				2	(1)	6-21			
Tetrachloroethene (PCE)	126	(91)	3.1-350,000	67	(33)	1.4-140	36	(13)	1-29			
Toluene	136	(99)	2-110,000	140	(68)	1-95	180	(66)	1-450			
Trichloroethene (TCE)	86	(62)	1-3,400	5	(2)	0.8-3.8	3	(1)	0.5-4.5			
Trichlorofluoromethane (F-11)	6	(4)	0.4-5.8	10	(5)	1.1-13	20	(7)	1.1-22			
Trichlorotrifluoroethane (F-113)	66	(48)	4-7,500	5	(2)	2.3-34	5	(2)	2-150			
Vinyl chloride	2	(1)	16-98									
Xylenes	104	(75)	0.9-33,000	47	(23)	1.1-88	29	(11)	1-40			
cis-1,2-Dichloroethene	59	(43)	12-2,200	3	(1)	2.8-3.8	1	(<1)	3.9			

450R B/au401/t521.wk3

standards precluded a more definite identification. Dichloromethane was detected at concentrations ranging from less than 1 ppmv to as high as 747 ppmv, with the high concentrations being measured from Tanks D1 and D2, with lesser amounts from the oil separator and less yet from other vessels downstream. 1,1,1-TCA, toluene, and PCE were frequently detected. The compound shown as methane in the results presented in section 4 is almost certainly not methane, but appeared in the chromatograms at the methane retention time and appeared in the SWTP sample from Phase A, also. The only compound in the SUMMA analysis that might be consistent with the field GC analysis is acetone. Further study is needed to clarify this situation.

5.2.3 SVOCs

Table 5.3 summarizes the frequency of detection and range of concentrations for the SVOC sampling. As discussed in section 4, no PAHs or PCBs were found in any of the air samples.

Source: As described in section 4, very few of the eighty-four SVOCs on the EPA SW8270 analyte list were detected in the emissions from the process unit on a regular basis. As the air sampling technique is designed to measure volatilized compounds, reflecting the major mechanism of transport to the air, the SVOCs found in source flux chamber samples are the more volatile of the listed compounds (i.e., the chlorobenzenes, naphthalene, methyl naphthalene, and phenol). None of the source samples showed the presence of any phthalates, while the ambient and process samples showed them frequently. Blending tanks D-1 and D-2 always showed the presence of the dichlorobenzenes; the blending tanks, oil separator, and equalization basins showed phenol, naphthalene, and methylnaphthalene.

Process and Ambient: All of the compounds detected in the source samples were also found in the PUF sampling at the process exposure and upwind/downwind ambient sampling locations. Several other compounds were also detected. These other compounds are not as volatile and are likely to exist as particulate matter, usually borne on dust particles. Compounds found were several of the phthalates (bis[2-ethylhexyl], bis[2-chloroisopropyl], and diethyl), and N-nitrosodiphenylamine. The phthalates may be a contaminant related to the PUF filter. However, there were several nondetects and a few comparatively high phthalate results. No phthalates were detected in the source samples. No PCBs were detected in these samples; the practical quantitation limit (PQL) for PCBs was about 160 ng/m³. The only PAH detected was phenanthrene at air station P6 (once) and at stations A6, A7, A8, and A10 with concentrations only slightly above the PQL of 16 ng/m³.

5.2.4 Formaldehyde

Formaldehyde samples were collected only during Phase A, according to the work plan. After review of preliminary results and according to the work plan, no formaldehyde sampling was done during Phase B.

Source: Samples were collected over a period of 7 days at all flux and probe source locations (S2-1, S2-2, S3, S5-1, S5-2, S9, S12). The PQLs for formaldehyde

Table 5.3
SVOC Air Analysis
Tinker AFB, Oklahoma

Analyte	Source 133			Process 200			Ambient 269		
	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$	No. of Hits	(%)	Conc. Range $\mu\text{g}/\text{M}^3$
1,2,4-Trichlorobenzene	1	(1)	49						
1,2-Dichlorobenzene	52	(39)	36-6,567	109	(55)	15-1,461	69	(26)	16-221
1,3-Dichlorobenzene	16	(12)	43-879	2	(1)	36-46	1	(<1)	24
1,4-Dichlorobenzene	24	(18)	42-2,214	54	(27)	17-314	32	(12)	16-100
2,4-Dimethylphenol	1	(1)	48						
2,4-Dinitrotoluene				1	(1/2)	314			
2-Chlorophenol				1	(1/2)	629			
4-Chloro-3-methylphenol				1	(1/2)	629			
4-Nitrophenol				1	(1/2)	629			
Acenaphthalene				1	(1/2)	314			
Acenaphthylene				1	(1/2)	28			
Bis(2-chloroisopropyl)ether				1	(1/2)	19			
Bis(2-ethylhexyl)phthalate				106	(53)	16-4,280	151	(56)	16-3,662
Di-n-butylphthalate				156	(78)	17-488	240	(89)	18-603
Di-n-octylphthalate				5	(3)	43-102	8	(3)	19-53
Diethylphthalate				19	(10)	16-256	39	(14)	17-94
Fluoranthene				1	(1/2)	98			
Fluorene				3	(2)	36-162			
Methylnaphthalenes	81	(61)	53-2,274	193	(97)	18-7,657	248	(92)	18-1,411
N-nitroso di-n-propylamine				1	(1/2)	314	2	(1)	22-32
N-nitrosodiphenylamine				29	(15)	16-62	29	(11)	16-41
Naphthalene	79	(59)	39-1,587	192	(96)	17-3,150	259	(96)	19-964
Pentachlorophenol				1	(1/2)	629			
Phenanthrene				4	(2)	16-17	10	(4)	16-27
Phenol	80	(60)	44-6,601	180	(90)	14-11,240	204	(76)	16-2,129
Pyrene				1	(1/2)	314			

ranged from 149.1 to 165.5 $\mu\text{g}/\text{m}^3$. Only two detections (295.5 and 990.8 $\mu\text{g}/\text{m}^3$ in S2-2 and S3 flux chamber samples, respectively) were reported on September 22, 1993. No detections were registered from the probe samples.

Ambient: The PQLs varied from 7.4 to 9.9 $\mu\text{g}/\text{m}^3$ over the sampling period. Only one sample was above the PQL (September 27, 1993, at A11, 8.0 $\mu\text{g}/\text{m}^3$).

Process: A total of thirteen detections at eight process locations were measured. Nine of these were below 15 $\mu\text{g}/\text{m}^3$; the other four were 89.6, 33.9, 108.6, and 25.5 $\mu\text{g}/\text{m}^3$. The readings of 89.6 and 108.6 $\mu\text{g}/\text{m}^3$ were made at stations P4 and P9, respectively, on September 22, 1993.

5.2.5 Phenol Analysis

Phenol air samples were collected from September 22 to November 8, 1993.

Source: Phase A samples were collected over a period of 7 days. At each of the seven source locations (S2-1, S2-2, S3, S5-1, S5-2, S9, S12), three flux and two probe samples were collected for a total of thirty-five samples. The PQLs for phenol varied from 147 to 165 $\mu\text{g}/\text{m}^3$ over the sampling period. All three S2-1 and S2-2 flux samples and one S9 sample contained measurable phenol concentrations. Phenol was detected in only one of the probe samples (S13) on September 27, 1993, at a concentration of 6,619 $\mu\text{g}/\text{m}^3$.

Phase B samples were collected at either S2-1 or S2-2, and S3, S5-2, and S9 on 17 days; a total of sixty-eight samples were collected. The PQLs varied from 155 to 163 $\mu\text{g}/\text{m}^3$, and phenol was consistently detected at all sources. Blank samples collected on November 2, 4, 6, and 8, 1993, were found to be contaminated. The source of this contamination was the reagent (0.1 N sodium hydroxide) used for phenol sampling. All samples taken on those days showed increased levels of phenol, but the sample values and reagent blank value are approximately equal. Therefore, the results effectively show nondetects at a higher PQL. Higher phenol concentrations were measured at S2-1 or S2-2 than were observed at S3, S5-2, and S9.

Ambient: On the 21 sampling days (Phase A and B), 269 samples were collected. No phenol was detected at any of the ambient locations; the PQLs for this compound varied from 99 to 523 $\mu\text{g}/\text{m}^3$ over the sampling period.

Process: A total of 210 samples were collected on the same days as ambient samples, and only one sample contained detectable phenol (P10 on October 15, 1993) at 112 $\mu\text{g}/\text{m}^3$, which was the PQL.

5.2.6 Hydrogen Sulfide Analysis

A Jerome gold foil analyzer was used to perform H_2S surveys in and around the expected sources of H_2S (the chemical mixing area and the solids contact clarifier). Relatively high concentrations of H_2S were detected at locations around S8 and S9. Based on these surveys, a program of ambient H_2S sampling was instituted. A wet chemical method, "ISC Method 701," was used to collect H_2S samples from seven ambient locations: A1, A2, A3, A7, A11, A12, and A13. Samples were collected twice a day for 9 days between October 25 and November 9, 1993, for a total of one

hundred and twenty-six samples. The PQLs varied from 3.48 to 5.63 $\mu\text{g}/\text{m}^3$ over the sampling period, and no H_2S was detected at any of the ambient locations.

5.2.7 Sulfide and Mercaptan Bag Samples

Tedlar bags were used to collect samples to be analyzed for organic sulfur compounds to determine whether odor resulted from organic sulfides or if odors were due to H_2S . A total of fifteen samples were collected from five locations around S9 over three different sampling days. On one of the days (October 7, 1993) Jerome analyzer was used to analyze the sample bags for H_2S prior to shipment to the laboratory for mercaptan analysis. H_2S was detected in these bags. All fifteen of these bag samples were analyzed for mercaptans (methyl through butyl) and mono- and disulfides (carbon and methyl) and none were detected at PQLs of 0.5 to 1.0 $\mu\text{g}/\text{m}^3$.

5.2.8 Meteorological Results

Using the data generated from the met towers, two wind roses were developed for the WWTF area, Figures 5.28 and 5.29. The prevailing winds are from the south. Strong winds (14.3 to 18 mph) from the south-southwest were recorded at met tower 1. The raw meteorological data are in appendix H.

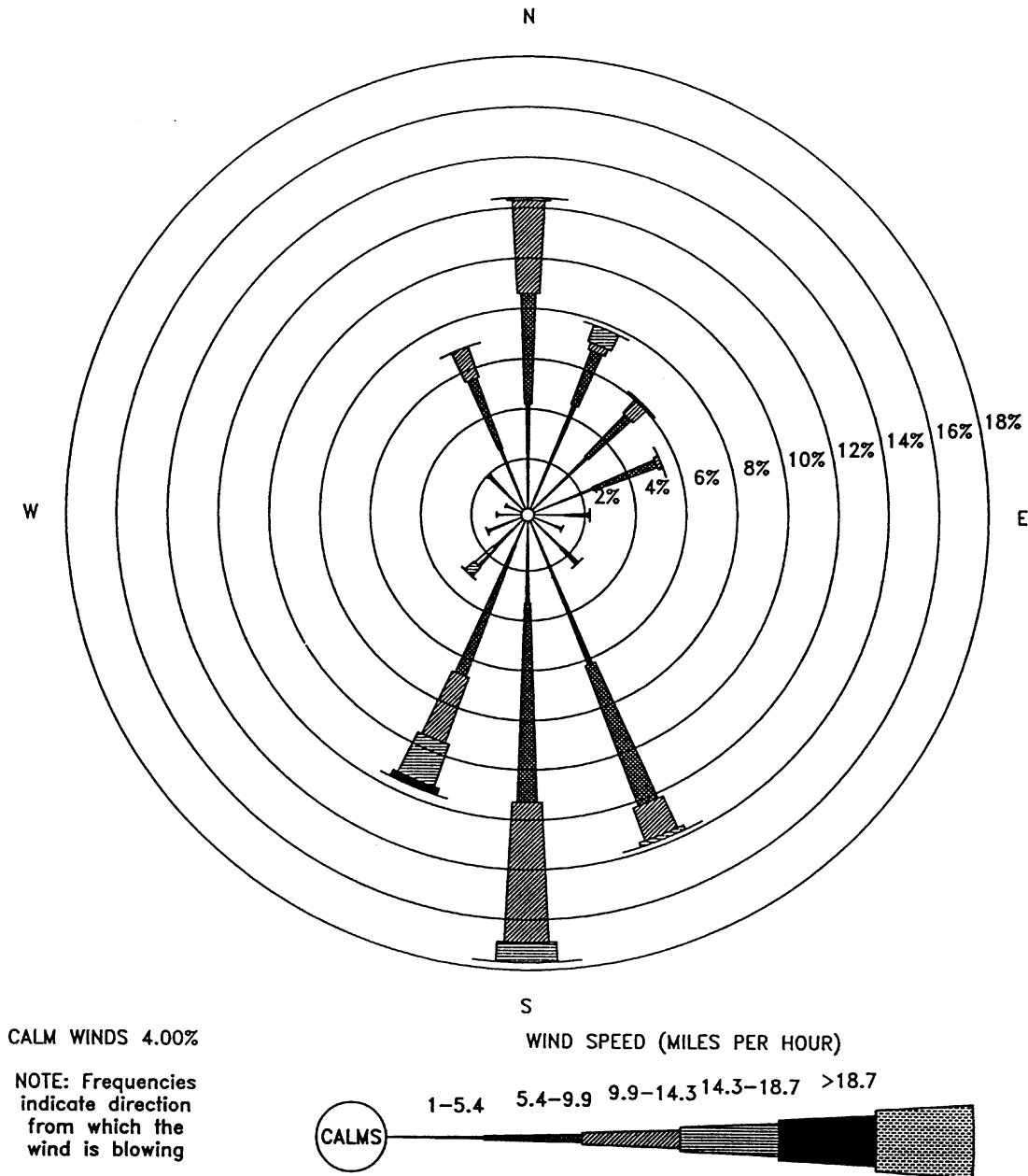
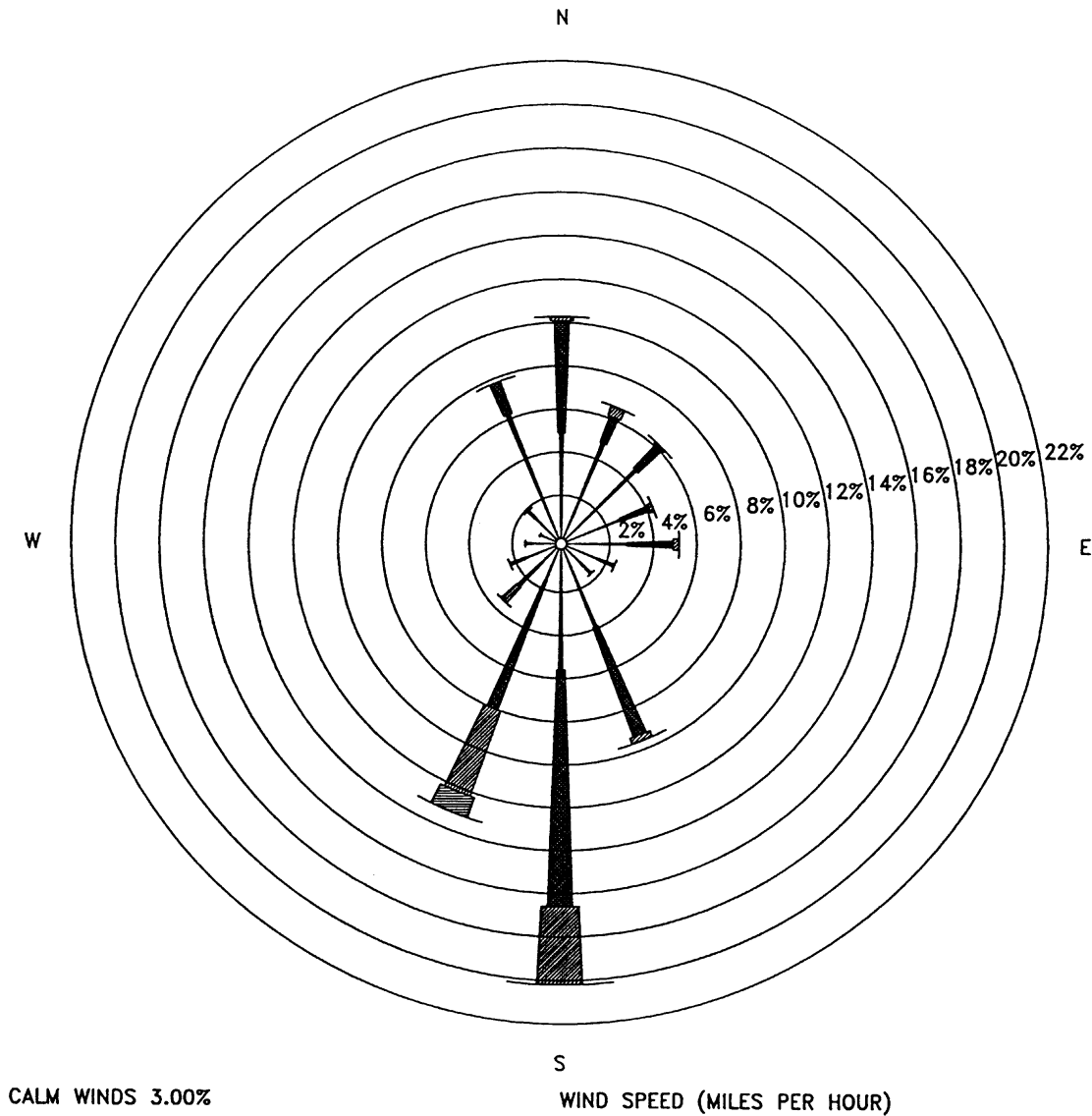


FIGURE 5.28
 WIND ROSE FOR
 MET TOWER M1

TINKER AFB, OKLAHOMA



CALM WINDS 3.00%

NOTE: Frequencies indicate direction from which the wind is blowing

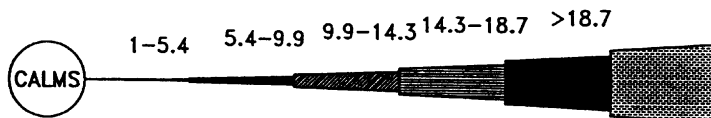


FIGURE 5.29
 WIND ROSE FOR
 MET TOWER M2

TINKER AFB, OKLAHOMA

SECTION 6

SUMMARY AND DISCUSSION

As shown in the previous sections, volatile organic, semivolatile organic, and inorganic constituents have been released to the soil from several SWMUs. Volatile and semivolatile organic constituents have also been released to the air from several of the SWMUs. Overall, the SWMUs with the most significant releases to the soil are located on the northwestern and southern areas of the WWTF. SWMUs of particular concern on the northwest side are SWMUs 24.2 and 24.3, along with the recirculation pit. SWMUs 24.19 and 32.8 at the southern end of the site also have significant releases to the environment.

As presented in sections 4 and 5, the constituents found in the soil gas and soil samples generally were either the same as those found in the influent wastewater samples or degradation products of these constituents. The primary constituents of the wastewater are acetone, gasoline fraction hydrocarbons, methylene chloride, phenol, PCE, barium, cadmium, and chromium. The volatile constituents found in the soil gas across the site were PCE and its degradation products TCE, DCE, and vinyl chloride, and TCA and the associated degradation products. The primary organics found in the soil samples were acetone, bis(2-methylethyl)phthalate, methylene chloride, phenol, PCE, and toluene. The primary inorganic contaminants in the soil were arsenic, barium, cadmium, chromium, selenium, and cyanide.

The physiochemical interactions between the environment and the contaminants found at WWTF and their relative impact at the site are discussed in this section. Section 6.1 describes general transport and fate mechanisms that may affect the movement and degradation of chemicals in the environment. Section 6.2 relates these processes to the groups of chemicals detected at the WWTF. Section 6.3 is an evaluation of analytical results and fate and transport processes affecting contaminant behavior and concentrations at the WWTP.

6.1 FATE AND TRANSPORT IN THE ENVIRONMENT

Fate and transport of contaminants in the environment are interrelated and interdependent concepts. Fate considers whether a contaminant is persistent in environmental media, and into which media a contaminant will partition. Transport deals with the partitioning and migration of contaminants within or between media. In many cases, the fate of a contaminant can depend on the transport phenomena that occur, and conversely, the modes available for transport of a contaminant can depend on the ultimate fate of the contaminant. For example, if a compound is

readily degradable in the atmosphere but persistent in dissolved or sorbed fractions, degradation cannot occur unless there is a transport mechanism to move the contaminant to the atmosphere. Also, if a compound is extremely persistent and is in contact with groundwater, groundwater transport of the contaminant may be important in the long term, even if the contaminant is relatively insoluble.

Assessing the fate of a contaminant involves determining what transformations the contaminant is likely to undergo and which media it is likely to affect when it is released into an environment. Transformation processes which may affect the behavior of a contaminant include chemical reactions, biodegradation, volatilization, dissolution, sorption, photolysis, and hydrolysis. The environmental media which may be affected include soil, water (groundwater and surface water), soil gas, and air. The significance of the effects of a contaminant depend greatly on the characteristics of the available media and the properties of the contaminant. Transport of a contaminant in a medium is dependent on which medium is affected (greater mobility is expected for a contaminant associated with water or air than for one associated with soil), the properties of the medium, and the properties of the contaminant.

In general, for addressing the environmental fate and transport of contaminants, the contaminants of concern can be categorized according to type, where the general properties and behaviors of the individual contaminants or compounds within a category are similar. The categories for the potential contaminants of concern for the WWTF at Tinker AFB are volatile chlorinated organic compounds, volatile nonchlorinated organic compounds, PAHs, phthalates, and heavy metals. The categories and potential representative contaminants are:

- Volatile chlorinated organic compounds:
 - PCE,
 - TCE,
 - TCA,
 - Isomers of dichloroethene (DCE),
 - Vinyl chloride,
 - Methylene chloride, and
 - Chloroform.
- Volatile nonchlorinated compounds:
 - Toluene,
 - Xylenes,
 - Acetone, and
 - 2-Butanone (MEK).
- PAHs:
 - Benzo(a)pyrene,

- Benzo(b)fluoranthene,
- Chrysene,
- Fluoranthene,
- Phenanthrene, and
- Pyrene.
- Phthalate compounds:
 - bis(2-ethylhexyl)phthalate, and
 - di-n-butylphthalate.
- Metals:
 - Arsenic,
 - Barium,
 - Cadmium,
 - Chromium,
 - Lead,
 - Mercury,
 - Nickel,
 - Selenium,
 - Silver, and
 - Zinc.

Physical constants for the potential organic contaminants of concern are summarized in Table 6.1. These physical constants influence the persistence and migration of contaminants in the environment.

6.1.1 Contaminant Persistence

Organic compounds can undergo a variety of chemical reactions which may transform one compound into another, change the state of the compound, or cause a compound to combine with other chemicals. Compounds may be resistant to these changes and may not readily undergo chemical reactions. When this occurs, the compounds are said to be persistent and may accumulate in the environment.

The behavior of heavy metals in the environment is unlike organic compounds in many respects. Elemental metals are not degraded, and thus are considered persistent in the environment. However, the chemical form of the metal may change, having a significant effect on the toxicity and mobility of the compound.

The processes and reactions described in the following discussion are the ones of greatest importance in the degradation of chlorinated and nonchlorinated organic compounds in the environment. Also presented are mechanisms which affect the chemical form of the metal compound in the environment.

Table 6.1
Fate and Transport Constants for Organic Compounds
Tinker AFB, Oklahoma

Volatiles	Solubility (a) mg/L		Vapor Pressure (a) torr		Henry's Law Constant (a) atm-m ³ /mol		log Koc log Kow	log Bf
Acetone	Miscible	(1)	270 @ 30	(2)	N/A	N/A	1.25	-0.24 (2) -0.01
Chlorobenzene	488 @ 25	(2)	11.8 @ 25	(2)	3.93 E-3 @ 25	(4)	2.92	2.84 (5) 1.66
Chloroform	9300 @ 25	(2)	160 @ 20	(2)	3.39 E-3 @ 25	(4)	2.45	1.97 (5) 1.19
Dichloroethene-cis	800 @ 20	(2)	202 @ 25	(6)	4.08 E-3 @ 24.8	(7)	N/A	N/A
Dichloroethene-trans	600 @ 20	(2)	331 @ 25	(6)	5.32 E-3 @ 25	(4)	2.18	1.48 (8) 0.93
Methyl ethyl ketone	2.75 E 5	(1)	100 @ 25	(3)	N/A	N/A	1.52	0.26 (2) 0.26
Methylene chloride	1.67 E 4 @ 25	(2)	429 @ 25	(6)	3.19 E-3 @ 25	(4)	2.06	1.25 (9) 0.80
PCE	150 @ 25	(2)	19 @ 25	(10)	2.87 E-2 @ 25	(4)	2.75	2.53 (11) 1.50
TCE	1100 @ 25	(2)	77 @ 25	(10)	1.17 E-2 @ 25	(4)	2.75	2.53 (12) 1.50
Toluene	515 @ 20	(2)	28 @ 25	(6)	5.92 E-3 @ 25	(4)	2.84	2.69 (5) 1.58
Vinyl chloride	1.1 @ 25	(2)	2580 @ 20	(2)	2.78 E-2 @ 25	(7)	1.70	0.6 (8) 0.45
Xylene-m	200	(2)	6 @ 20	(2)	N/A	N/A	3.12	3.2 (2) 1.86
Xylene-o	175 @ 20	(2)	5 @ 20	(2)	5.27 E-3 @ 25	(14)	2.88	2.77 (2) 1.63
Xylene-p	198 @ 25	(2)	6.5 @ 20	(2)	N/A	N/A	3.09	3.15 (2) 1.83
Semivolatiles								
1,2-Dichlorobenzene	145 @ 25	(2)	1.5 @ 25	(2)	1.94 E-3 @ 25	(4)	3.22	3.38 (5) 1.96
1,4-Dichlorobenzene	79 @ 25	(2)	1.8 @ 30	(2)	2.72 E-3 @ 25	(4)	3.22	3.39 (5) 1.96
2-Chlorophenol	2.85 E-4 @ 20	(2)	N/A	N/A	1.03 E-5 @ 20	(13)	2.55	2.15 (5) 1.29
2-Methylnaphthalene	26 @ 25	(12)	N/A	N/A	N/A	N/A	3.48	3.86 (12) 2.22
2-Methylphenol (o-cresol)	3.1 E 4 @ 40	(2)	0.24 @ 25	(2)	N/A	N/A	2.44	1.95 (5) 1.18
2,4-Dimethylphenol	N/A	N/A	N/A	N/A	1.7 E-5 @ 25	(13)	2.69	2.42 (11) 1.44
4-Chloro-3-methylphenol	3846 @ 20	(1)	N/A	N/A	N/A	N/A	3.06	3.1 (2) 1.80
4-Methylphenol (p-cresol)	2.4 E 4 @ 40	(2)	0.11 @ 25	(2)	N/A	N/A	N/A	N/A
Acenaphthene	3.42 @ 25	(8)	N/A	N/A	2.41 E-4 @ 25	(4)	3.51	3.92 (12) 2.25
Anthracene	1.29 @ 25	(2)	N/A	N/A	8.6 E-5 @ 25	(13)	3.80	4.45 (8) 2.54
Benzoic acid	2900 @ 20	(1)	N/A	N/A	N/A	N/A	2.39	1.87 (2) 1.14
Benzo(a)anthracene	0.010 @ 24	(2)	5 E-9 @ 20	(8)	N/A	N/A	4.43	5.61 (8) 3.16
Benzo(a)pyrene	0.0038 @ 25	(8)	5 E-9 @ 20	(8)	4.9 E-7 @ 25	(13)	4.63	5.98 (12) 3.37
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	4.95	6.57 (8) 3.68
Benzo(g,h,i)perylene	2.6 E-4 @ 25	(2)	1 E-10 @ 20	(8)	N/A	N/A	5.31	7.23 (8) 4.04
Benzo(k)fluoranthene	N/A	N/A	9.59 E-11 @ 20	(8)	N/A	N/A	5.10	6.84 (8) 3.83
bis(2-Ethylhexyl)phthalate	0.4 & 1.3 @ 25	(8)	N/A	N/A	3 E-7 @ 20	(13)	4.26	5.3 (8) 3.00
Butylbenzylphthalate	2.9	(2)	8.6 E-6 @ 20	(2)	N/A	N/A	3.98	4.78 (2) 2.71
Chrysene	0.006 @ 25	(2)	6.3 E-9 @ 25	(13)	1.05 E-6 @ 25	(13)	4.43	5.61 (8) 3.16
Dibenzofuran	10	(11)	N/A	N/A	N/A	N/A	3.62	4.12 (5) 2.36
Dibenzo(a,h)anthracene	0.0005 @ 25	(8)	N/A	N/A	7.3 E-8 @ 25	(13)	4.62	5.97 (8) 3.36
Diethylphthalate	N/A	N/A	N/A	N/A	N/A	N/A	2.99	2.96 (16) 1.73
di-n-Butylphthalate	400 @ 25	(2)	N/A	N/A	2.8 E-7 @ 25	(13)	4.21	5.2 (8) 2.94
di-n-octylphthalate	3 @ 25	(8)	N/A	N/A	N/A	N/A	6.38	9.2 (8) 5.11
Fluoranthene	0.265 @ 25	(2)	N/A	N/A	6.5 E-6 @ 25	(13)	4.28	5.33 (8) 3.01
Fluorene	1.9 @ 25	(2)	N/A	N/A	1.17 E-4 @ 25	(4)	3.65	4.18 (12) 2.39
Indeno(1,2,3-c,d)pyrene	N/A	N/A	N/A	N/A	6.95 E-8 @ 25	(13)	5.54	7.66 (8) 4.28
Naphthalene	30 @ 25	(2)	0.082 @ 25	(10)	4.83 E-4 @ 25	(17)	3.21	3.37 (5) 1.95
Penta chlorophenol	14 @ 20	(2)	1.1 E-4 @ 20	(2)	2.8 E-6 @ 20	(13)	4.10	5.01 (5) 2.84
Phenanthrene	0.816 @ 21	(2)	N/A	N/A	3.93 E-5 @ 25	(17)	3.80	4.46 (5) 2.54
Phenol	8 E 4 @ 25	(10)	0.35 @ 25	(10)	1.3 E-6 @ 25	(4)	2.17	1.46 (5) 0.92
Pyrene	0.16 @ 26	(2)	N/A	N/A	5.1 E-6 @ 25	(13)	4.19	5.18 (12) 2.93

430R/B/123x34/hu401/01656c.wk3

Bf = Bioconcentration factor for trout, calculated by $\log Bf = 0.542 \cdot \log Kow + 0.124$ (Verscheuren 1983)

N.A. = Applicable value was not found in the literature

(a) Temperature given in degrees Celsius

Koc = Organic carbon partition coefficient, calculated by $\log Koc = 0.544 \cdot \log kow + 1.377$ (Dragun, 1988)

Kow = Octanol/water partition coefficient

atm-m³/mol = atmospheres - cubic meters per mole

(1) Merck & Co. Inc., 1983

(2) Verscheuren, K., 1983

(3) CRC Press, Inc.

(4) Convery, J.J., J.M. Cohen and D.F. Dishop, 1980

(5) Leo, A., C. Hansch and D. Elkins, 1971

(6) Dean, J.A., 1985

(7) Gossett, J.M., 1987

(8) Callahan, M.A., M.W. Slimak, et.al., 1987

(9) Hansch, C., A. Vittori, C. Silipo and P.Y.C. Jow, 1975

(10) Patty, F.A., 1963

(11) Banarjee, S., S.J. Yalkowsky, and S.C. Valvani, 1980

(12) Miller, M.M., S.P. Wasik, G.L. Huang, W.Y. Shiu, and D. Mackay, 1985

(13) Mabey, W.R., J.N. Smith, R.T. Podoll, H.L. Johnson, T. Mill, T.W. Chou, J. Gates, I.W. Partridge and D. Vandenberg, 1982

(14) Mackay, D. and P.J. Leinonen, 1975

(15) NIOSH, 1979

(16) Garst, J.E., 1984

(17) Mackay, D., W.Y. Shiu and R.P. Sutherland, 1979

Hydrolysis. Hydrolysis is the direct reaction of dissolved compounds with water molecules. Hydrolysis is usually an insignificant degradation process for chlorinated organic compounds, although it can be a significant degradation process for non-chlorinated organic compounds.

Photolysis. Photolysis is the degradation of organic compounds by the action of light. Light is absorbed by the compound, resulting in a chemical reaction involving molecular rearrangement, disassociation, or oxidation. Photolysis is not expected to be a significant degradation process.

Biodegradation. Chlorinated and nonchlorinated organic compounds can be degraded by aerobic and anaerobic bacteria. The intermediate compounds and end-products of degradation also can be of concern. For example, the anaerobic degradation of PCE may proceed through TCE, DCE, and finally to vinyl chloride, through the successive replacement of the chlorine atoms with hydrogen (dehalogenation). Vinyl chloride is not readily degraded and tends to accumulate in the soil gas. Aerobic degradation can, in the presence of a cosubstrate such as methane, degrade some chlorinated organic compounds. This pathway has not been shown to produce vinyl chloride as an end product. PCE and TCE, however, have not been shown to be effectively degraded aerobically. Nonchlorinated organic compounds such as phenol, acetone, and jet fuel are readily biodegraded. Microorganisms are rapidly acclimated to these compounds, and half lives can be as short as 1 or 2 days.

Oxidation and reduction. Oxidation and reduction involve changing the valence states of metals and substantially influence fate mechanisms, including leaching. An example of the variation in contaminant fate due to oxidation and reduction changes can be demonstrated for chromium. Chromium (Cr) normally exists in one of two valence states, trivalent (+3) and hexavalent (+6) [Cr(III) and Cr(VI)]. Cr(VI), which is far more soluble than Cr(III), frequently exists in groundwater as CrO_4^{2-} . Cr(III) is the dominant form of chromium present in soils under oxidizing conditions (aerobic), while Cr(VI) would be more prevalent under reducing conditions (anaerobic).

6.1.2 Contaminant Migration

Media which act as migration pathways include soil in the unsaturated (i.e., vadose) zone, groundwater, surface water, soil gas, or air. Physical properties of the affected media greatly influence the mobility of contaminants. For instance, the effective porosity of the soil (i.e., the percentage of interconnected void space within the soil) is an indication of the space available for transport processes to work. The lower the effective porosity of the soil, the less mobile contaminants will be, regardless of the operating process. Soil properties such as chemistry, organic content, cation exchange capacity, moisture content, temperature, air pressure, and soil and water quality affect migration of contaminants. The characteristics of the contaminants also affect the potential for contaminant migration. Transport mechanisms in soil can include advection, adsorption, volatilization, dispersion, diffusion, and evapotranspiration.

Contaminants can be transported to the groundwater system in one or more of the following three ways. First, contaminants may dissolve into the aqueous phase when rainwater percolates through a contaminated soil column to the groundwater surface (i.e., leaching). Second, hazardous constituents may also dissolve directly into the groundwater if the soil is contaminated at the capillary fringe or below the water table, or during wet seasons when the water table rises to the elevation of soil contamination. Third, contaminants can be released directly into the groundwater system, as in the case when a below-grade tank or pipe leaks in an area of shallow groundwater.

Leaching. Leaching of metals from soil is controlled by many factors. The most important consideration for leaching of heavy metals is the chemical form (base metal or cation) present in the soil. The leaching of metals from soils can be substantial if the metal exists as a soluble salt. In general, metal oxides are considered less likely to leach metallic ions than are metallic salts. Upon contact with surface water or precipitation, the heavy metals can become soluble, eventually leaching into the groundwater. Leaching of organics is controlled by solubility of the organic and the length of time the waste is in contact with the water.

Adsorption. Adsorption commonly refers to the binding of metals or organic compounds to soil or sediment particles. Some compounds adsorb more strongly to the clay fraction of a soil or sediment, but many organic compounds, and some metals, adsorb more strongly to the organic fraction of the soil or sediment. In these cases, the higher the organic content in the soil, the less mobile these migrating organic compounds will be. Generally, surface soils and sediments have higher organic content than deeper soils because of decomposed vegetation. The organic carbon partitioning coefficient, K_{oc} , is a measure of the affinity of a compound for the organic fraction of the soil. K_{oc} is the ratio of the amount of a compound in the organic fraction to that in the aqueous fraction. For example, acetone is completely miscible with water and has a K_{oc} of 1, whereas PCBs are insoluble in water, with a K_{oc} of 63,914. K_{oc} values for certain compounds detected in the IWTP and SWTP areas are listed in Table 6.1.

Advection. Advection, a mass transport process, contributes to the physical spreading of contaminated groundwater. Advection is flow of a contaminant with the groundwater. The groundwater flow velocity depends on physical characteristics of the formation through which the groundwater is flowing, such as hydraulic conductivity, gradient, and effective porosity. Contaminants undergoing adsorption during advection will move at a rate less than the groundwater flow velocity. The retardation factor is the proportion of a contaminant undergoing adsorption during advection.

Volatilization. Volatilization is the process whereby VOCs partition into the gas phase from soil or water. The tendency of a compound to volatilize is usually expressed in terms of a Henry's Law constant. Henry's Law states that the solubility of a nonreactive gas in a dilute solution (such as groundwater) is proportional to the partial pressure of the gas above the solution. The proportionality factor is the Henry's Law constant, K_H . K_H increases with decreasing solubility and increasing

vapor pressure. Henry's Law constants for a number of organic compounds detected in the IWTP and SWTP areas are listed in Table 6.1.

Dispersion. Dispersion is also a mass transport process. Dispersion is the outward spreading of a contaminant plume caused by differences in water velocities in larger and smaller pores of the soil or rock. In most cases, the effects of advection are much greater than the effects of dispersion. However, if groundwater flow velocity is very low, dispersion may be the dominant transport mechanism.

Diffusion. Diffusion is the molecular movement from areas of high concentration to areas of low concentration within a single medium, such as groundwater or air. Diffusion is the dominant mechanism of contaminant transport only when velocity and retardation factors are negligible.

Evapotranspiration. Evapotranspiration is the loss of surface water or groundwater through evaporation, and/or by transpiration of water by plants. Organic contaminants may be transported into the air along with this water. The amount of contaminant transport which occurs via evapotranspiration is expected to be negligible in comparison with the other transport mechanisms.

6.2 FATE AND TRANSPORT OF CONTAMINANTS AT WWTF

6.2.1 Volatile Chlorinated Organic Compounds

The volatile chlorinated organic compounds are characterized by low to moderate solubilities, high to very high Henry's Law constants, and low to moderate octanol/water coefficients, which suggest that in the environment they will adsorb to soil to a moderate to low degree and will be subject to transport through dissolution in groundwater and volatilization into the soil gas or the atmosphere.

Volatile chlorinated organic compounds, with the exception of PCE and its degradation byproducts, can be degraded under aerobic conditions. The volatile chlorinated organic compounds also can be degraded under anaerobic conditions where reductive dechlorination occurs, although the presence of cosubstrates may be necessary, especially for complete dechlorination to occur. Anaerobic degradation of PCE proceeds successively to TCE, to isomers of DCE, to vinyl chloride, and finally to ethylene, provided conditions conducive to degradation are present. Typically in subsurface environments, conditions are not optimal for degradation of vinyl chloride at a significant rate. As a result, vinyl chloride may accumulate, and is often present at sites where PCE, TCE, and/or DCE contamination are present and anaerobic degradation is occurring. Vinyl chloride is a vapor at environmental temperatures, and therefore exists in the soil gas.

Bioconcentration in aquatic organisms may occur to a moderate degree for PCE and TCE, as shown by the relatively high bioconcentration factor (BF) in Table 6.1. However, the other volatile chlorinated organic compounds are not expected to bioconcentrate significantly.

6.2.2 Volatile Nonchlorinated Organic Compounds

The volatile nonchlorinated organic compounds are characterized by solubilities that are low to miscible (acetone), high vapor pressures, and extremely low to

moderate octanol/water coefficients, which suggest that in the environment they will adsorb to soil to a moderate to low degree and will be subject to transport through dissolution in groundwater and volatilization into the soil gas or the atmosphere. Volatile nonchlorinated organic compounds can be degraded under aerobic and anaerobic conditions, although sufficient nutrients, moisture, and a viable biomass are required for degradation to proceed at a significant rate. Bioconcentration in aquatic organisms may occur to a moderate degree for compounds such as toluene, but is not expected to occur for compounds such as acetone.

6.2.3 Polynuclear Aromatic Hydrocarbons

The PAHs are characterized by low solubilities, low Henry's Law constants, and high octanol/water coefficients, which suggest that in the environment they will adsorb to soil and sediment, and will not be subject to transport through dissolution in surface or groundwater or volatilization into the soil gas or the atmosphere. PAHs are subject to degradation under aerobic and anaerobic conditions, although nutrients and a viable biomass are required for degradation to proceed at a significant rate. PAHs have a tendency to bioconcentrate in aquatic organisms.

6.2.4 Phthalate Compounds

The phthalate compounds are characterized by low solubilities and low Henry's Law constants, which suggest that in the environment they will adsorb to soil and sediment and will not be subject to transport through dissolution in surface or groundwater or volatilization into the soil gas or the atmosphere. Phthalates have been successfully degraded in river and lake water in which microorganisms have become acclimated to the concentrations present, as well as in acclimated activated sludge treatment systems. Degradation does not occur in unacclimated systems or under anaerobic conditions in water/sediment mixtures. Biodegradation is possible in unsaturated soil, but may be limited and dependent upon oxygen levels, the presence of a viable biomass, and other factors. Phthalates have a tendency to bioconcentrate in aquatic organisms, and experimental BFs range from a log of 2 to 4 (Howard, 1989).

6.2.5 Heavy Metals

The behavior of heavy metals in the environment is unlike organic compounds in many respects. For example, volatilization of metals from soil is not considered a realistic mechanism for contaminant migration. Leaching and sorption are, however, significant modes of transport of metals. Behavior of a few of the metals found at the WWTF is discussed below.

Barium. Although environmental fate mechanisms may transform barium compounds, barium itself is not degraded. Barium in sediments is found largely in the form of barium sulfate. Bioaccumulation is minimal in freshwater aquatic organisms. Barium is not highly mobile in soil. The primary transport mechanisms include dissolved barium transported by precipitation or taken up, to a small extent, by vegetation (USPHS/USEPA, 1990).

Cadmium. Cadmium may leach into groundwater from soils, especially under acidic conditions. Under neutral or basic soil conditions, cadmium will adsorb

strongly to clays. The soil pH affects the uptake of cadmium by plants, and acidic conditions increase its mobility.

Chromium. The dominant environmental form of Cr is the oxidized form, Cr(III); Cr(VI), the most toxic form, occurs in groundwater and surface waters. Cr(VI) represents a greater threat to receptors exposed to these media.

Lead is relatively immobile in water and soil. Environmental processes may transform one lead compound to another; however, lead is generally present in the +2 oxidation state. Lead is largely associated with suspended solids and sediments in aquatic systems, and occurs in relatively immobile forms in soil.

6.3 EXPLANATION/SIGNIFICANCE OF RESULTS

The following subsections compare and discuss the RFI results for the Tinker AFB WWTP site. Several different methods were used to test the soil, sediment, and air media. From the data acquired, relationships are presented between the WWTF influent and the SWMU contamination. Once these relationships are demonstrated, the nature of contaminant occurrence in the soil is discussed by comparing the soil gas results with the surface and subsurface analytical results. Finally, the location and potential migration paths of contamination in the soil are related to the soil's physical characteristics at the site.

6.3.1 Wastewater and Release from SWMUs

Contaminants found in the various samples collected from the SWMUs correspond to those present in wastewater received by the treatment plants over the life of the facility. Acetone, methylene chloride, PCE, and phenol are common industrial solvents used at Tinker AFB. Bis(2-ethylhexyl)phthalate is a commonly used plasticizer found in many products such as plastic, pipe, tapes, and glues on the site. The metals barium, cadmium, and chromium are generated in aircraft maintenance procedures. These wastewater constituents were all found in soil samples collected from around the SWMUs and the sediment samples from East Soldier Creek.

Although the presence of contaminants at the site has been determined, the mass of contaminants in the soil at the SWMUs is not readily estimated. Surface and subsurface samples were collected on the basis of contamination detected during field activities, not at a pre-determined depth or geologic interval. Therefore, isopleth contouring would not be meaningful for estimating the spatial distribution or mass of the contaminants. Additionally, the laboratory data include estimated concentrations of several contaminants. As part of the data validation process, acetone, methylene chloride, bis(2-ethylhexyl)phthalate, and phenol analytical results generally have been flagged as estimated quantities due to laboratory blank contamination. The results for these compounds may be false positives or may be biased high. For several of the samples with apparent phenol contamination, the detections are clearly the result of laboratory contamination. A complete discussion of the data validation results is presented in appendix J.

Limited information is available concerning past releases from the treatment units at the WWTF. Previous reports have attributed releases to leaking wastewater lines or abandoned tanks (ES, 1993a). The lift station 2, tanks D-1 and D-2, and the oil separator have each had several overflows (ES, 1993a). This information correlates with the areas of contamination identified during the RFI.

6.3.2 Soil Gas vs Soil Boring Results

Soil gas samples contained primarily chlorinated ethene compounds, especially vinyl chloride, while the soil samples contained acetone, methylene chloride, and some PCE. The differences can be attributed to a number of physical and chemical factors.

The first difference is sample depth. The soil gas samples were collected 5 feet bgs, and the soil boring samples were generally collected at greater depths. Physical characteristics of stratigraphic layers in the subsurface may restrict the migration of gas through the subsurface. At the southwestern end of Tanks D-1 and D-2, vinyl chloride was not measured at high concentrations at 5 ft bgs; however, while drilling in the same location, high levels of vinyl chloride were detected (with Sensidyne® tubes) at 7 feet bgs.

Chemical properties have a significant effect on the presence or absence of a contaminant in a sample. Acetone is volatile; however, it is also miscible in water; therefore, it associates freely with the moisture in the subsurface soils. Vinyl chloride is a vapor, practically insoluble in water, and has a low partition coefficient. Therefore, vinyl chloride would not be expected in the soil samples, because it escapes during the drilling process. Vinyl chloride is, however, readily measured in the soil gas. Phenol is not volatile (vapor pressure 0.35 torr) and is soluble in water (80,000 mg/L); therefore, it was not detected in the soil gas, but was detected in the soil samples.

The PAHs found in the surface soil samples are not highly mobile in the soil. Low solubility and low vapor pressures prevent substantial migration by leaching or volatilization; hence, they were not detected in the soil gas. These compounds were only found in the shallow soils. These compounds adsorbed to soil particles could be transported by runoff during heavy rains and could ultimately migrate to surface waters (and sediment).

6.3.3 Contamination Related to Soil Type

Generally, the northern and western regions of the WWTF (SWMUs 21.1 through 24.3) are located on silt and/or clay layers with continuous sands beginning at about 15 feet bgs. The eastern, southeastern, and central regions of the WWTF (including SWMUs 32.8 and 24.19) are generally lower in elevation, and the underlying continuous sands are closer to the surface.

The sands and clays at the site have relatively low organic contents (0.8-5.6 percent). Therefore, the hydrophobic VOCs (e.g., vinyl chloride) present partition into the soil gas. The hydrophilic VOCs (e.g., acetone) partition into any soil moisture present.

Soil moisture (as measured in the geotechnical samples) is relatively high, ranging from 4.9 percent at SWMU 24.8 to 22.4 percent at SWMU 32.2. The average moisture content of the soil samples analyzed is 13.6 percent. This moisture provides a medium in which acetone and other soluble compounds can exist within the soil column.

As determined by constant-head permeability tests in the laboratory, the average site permeability for the clays and silts tested is $4.21\text{E-}7$ centimeters per second (cm/sec), and the average permeability of the sands tested is $7.73\text{E-}6$ cm/sec.

There is no readily apparent control of contaminant distribution by the different soil types. The VOCs and SVOCs are as widely distributed in the silts and clays as they are in the sand materials. Dense nonaqueous-phase liquids (DNAPLs) such as PCE and TCE may have migrated through the upper soils into the groundwater, where they may act as a continuing source of dissolved contaminants in groundwater.

SECTION 7

RECOMMENDATIONS

The Tinker AFB RFI addressed the potential releases from twenty SWMUs and the recirculation pit (non-SWMU) at the WWTF. Results of the investigation are presented for each SWMU in section 4 and on an area-wide scale in section 5. This section summarizes the finding of the RFI and presents recommendations for each SWMU.

The recommendations presented here are based on an overall evaluation of the evidence of releases from each SWMU and the magnitude of releases, rather than a specific concentration. No specific action limits have been established for remediation of subsurface soils at this site. General comparison criteria were consulted during the evaluation, including a range of background concentrations of metals in soils previously presented. Other comparison criteria are found in the proposed action levels listed in "Corrective Action for Solid Waste Units at Hazardous Waste Management Facilities, Proposed Rule" (EPA 1990). Some of the compounds and action level concentrations include: PCE, 10 mg/kg; bis(2-ethylhexyl)phthalate, 50 mg/kg; acetone, 8,000 mg/kg; barium, 4,000 mg/kg; and cadmium, 40 mg/kg. The concentrations of the constituents in the soil samples from the SWMUs at the WWTF were considerably less than these proposed action levels.

Samples collected from each SWMU showed some degree of releases from the units. The actual levels of some contaminants in samples may be artificially high because several constituents of the industrial wastewater treated at the facility are also common laboratory contaminants, including acetone, methylene chloride, and bis(2-ethylhexyl)phthalate.

To simplify the discussion and make recommendations, the analytical results of the RFI were grouped into three general contamination categories: *trace*, *low*, and *elevated* levels. Contamination in the soil gas or soil was considered to be at trace levels when constituents were detected below the quantitation limit. Samples containing constituents at concentrations near the quantitation limit or in soil below the Tinker AFB average background concentrations are categorized as low levels. Elevated concentrations are those that are substantially above the quantitation limits or the average background soil concentrations.

The SWMUs recommended for a corrective measures study (CMS) are those with clear evidence of significant releases to the environment. If the use of the site changes in the future, the sites which are recommended for no further action at this time may need to be reevaluated. Interim corrective measures to address

immediate impacts to human health and the environment are not needed at this time. The results of the investigation did not indicate adverse exposure to hazardous constituents is occurring or imminent.

Subsections 7.1 and 7.2 list the SWMUs which are recommended for no further action or a CMS, respectively. A brief synopsis of the investigation results is included.

7.1 NO FURTHER ACTION

Given the nature of the contamination and present use of the site, no further action is recommended for the following SWMUs at this time. However, corrective measures studies may be necessary at some SWMUs if future site uses change.

SWMU 24.1 (Lift Station) Low levels of chlorinated solvents and BTEX compounds were detected in the soil gas. Soil samples contained low concentrations of methylene chloride. One sample contained a high concentration of barium at 16 ft BGS. The concentrations of constituents in the samples are not consistent with a significant release from this unit.

SWMU 24.4 (Valve Vault) Soil gas samples were not collected at this SWMU. Nearby soil gas samples contained trace concentrations of DCE. One soil boring was drilled at this SWMU. Low concentrations of acetone were present throughout the soil boring. Metal concentrations were within the range of background concentrations.

SWMU 24.5 (Equalization Basin) Low levels of chlorinated solvents were found in the soil gas samples. PCE was detected at low levels and arsenic, barium, chromium, and cadmium concentrations were within background ranges in surface soil. Trace to low concentrations of toluene were measured in the subsurface soil samples. While evidence of a release is present, the concentrations do not appear to warrant a CMS at this time.

SWMU 24.6 (Main Flow Valve) Soil gas samples contained trace levels of DCA. Low concentrations of acetone were detected in soil samples. The concentrations of metals were within background ranges for the area.

SWMU 24.7 (Mixing Basins 1, 2, 3) Trace levels of DCE were detected in the soil gas, and low concentrations of acetone were detected in soil samples.

SWMU 24.8 (Solids Clarifier) Trace concentrations of PCE and DCE were found in the soil gas. Low levels of acetone and methylene chloride were detected in soil samples. The concentrations of metals were within background ranges.

SWMU 24.9 (Wet Well Lift Station) Trace levels of PCE and toluene and low levels of DCE were found in the soil gas. PCE was detected in one shallow soil sample. Metal concentrations were within background ranges.

SWMU 32.1 (Parshall Flume) Soil gas samples contained trace concentrations of DCE. Soil samples contained low levels of acetone. PCE, toluene, and chloroform were detected in one sample. The surface soil samples contained trace levels of PAHs.

SWMU 32.2 (Flocculation Chambers) Low levels of DCE and vinyl chloride were found in the soil gas. Low levels of acetone, methylene chloride, and phthalates were detected in soil samples and laboratory blanks. Arsenic concentration in one soil sample was above the background concentrations range.

SWMU 32.3 (Primary Clarifiers) One soil gas sample contained low levels of DCE and DCA. Soil samples contained low levels of acetone and methylene chloride. One soil sample also contained several PAHs at low concentrations.

SWMU 32.4 (Trickling Filters) All of the soil gas samples contained trace levels of DCE, and most contained PCE and DCA. Toluene was detected at low levels in three soil gas samples. Low levels of toluene and PCE were also found in the soil samples. Arsenic concentration was above background ranges in one soil sample. Although there is evidence of a release, the concentrations of contaminants do not appear to warrant a CMS at this time.

SWMU 32.5 (Final Clarifiers) Acetone, methylene chloride, PCE, and toluene were detected in soil samples. Several soil samples contained phenol compounds which were a result of laboratory contamination.

SWMU 32.6 (Former Chlorine Contact Chamber) Soil gas samples collected at this site did not contain any target compounds. No volatile organic compounds were detected in the soil sample. The phenol compounds were reported by the laboratory as spiking contamination.

7.2 CORRECTIVE MEASURES STUDY

Results from this investigation indicate that several SWMUs have had significant releases to the environment. A corrective measures study is necessary to identify and develop corrective measure alternatives for sites which may pose a threat to human health or the environment. A CMS is recommended for the following SWMUs:

SWMU 24.2 (D-1 and D-2 Tanks) Soil gas samples contained moderate to high concentrations of vinyl chloride. Subsurface soils had moderate concentrations of acetone, MEK, and toluene. Surface soils were contaminated with PAHs and several other compounds. Surface soils also showed visible evidence of releases, including stains and stressed vegetation.

SWMU 24.3 (Oil Separator) Soil gas samples indicated contamination by chlorinated solvents, especially vinyl chloride. Subsurface soils did not have high concentrations of contaminants. Low concentrations of benzoic acid and phthalates were detected in several subsurface soil samples. Metals concentrations were below average background concentrations. Surface soils were contaminated with low to moderate concentrations of hexanone, toluene, xylene, and phthalates, and low concentrations of Aroclor 1254. Arsenic, cadmium, and chromium were also detected in surface soils at elevated levels.

SWMU 24.10 (Softener Basins) Soil gas samples contained trace levels of chlorinated solvents. PCE, acetone, methylene chloride, and toluene were found in

soil samples. Several PAHs were found in one soil boring at 6-7 feet bgs. Mercury was detected in two samples.

SWMU 24.11 (Activated Sludge Unit) Soil gas samples contained trace concentrations of DCE and DCA. PCE was detected in one subsurface sample. The apparent phenol contamination in several soil samples was the result of laboratory contamination. Metal concentrations were within background ranges.

SWMU 24.12 (Secondary Clarifier) Low concentrations of DCE and trace amounts of DCA and PCE were detected in all soil gas samples. PCE was detected in two soil samples. Concentrations of barium were detected in subsurface soil samples above the background range.

SWMU 24.19 (Industrial Sludge Drying Beds) Very high concentrations of chlorinated solvents were detected in the soil gas samples. PCE and DCE were detected in most soil samples. Cyanide, PCBs, and high concentrations of all metals except arsenic, selenium, and zinc were detected in surface soils.

SWMU 32.8 (Drying Beds) High levels of TCE, TCA, DCA, and PCE were detected in the soil gas. Acetone, PCE, and toluene were detected in most of the soil samples.

Recirculation Pit Soil gas samples contained both DCE and DCA. High concentrations of gasoline components, including ethylbenzene, toluene, and xylene, were found in the soil samples. The soil samples also contained elevated levels of barium and chromium.

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